JULY 1955

WIRE AND WIRE PRODUCTS

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for Your Wire Drawing Program

The basic ability of Vaughn Motoblox to draw wire smoothly and dependably at higher rates of speed—year in and year out—assures profitable production on schedules of every type. Write for a consultation.

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COMPLETE COLD DRAWING EQUIPMENT—Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

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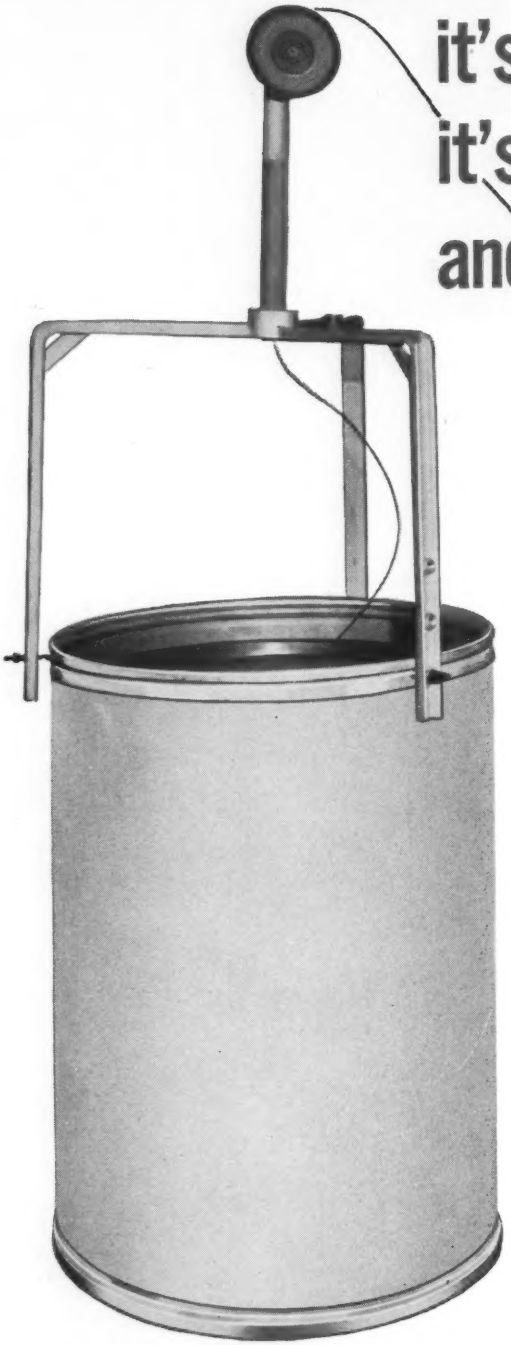
Payoffpak...®

it's new...it's different... it's ideal for handling and processing WIRE!



PAYOFFPAK—Continental's newest fibre container—offers wire manufacturers and fabricators a revolutionary new development in wire packaging, handling and dispensing.

SAVES WORK—Wire is automatically packaged in the Payoffpak as it is drawn, eliminating such operations as stripping, tying, handling, splitting and wrapping.

SAVES TIME—Payoffpak can hold 600 lbs. Downtime on the wire drawing machine, due to stripping operations, is greatly reduced.

ELIMINATES REELS—Single standard-size Payoffpak eliminates reels and need for wide range of block sizes.

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A survey indicates that often more than 50 labor steps are needed to convert 500 pounds of steel wire in standard eight inch coils—but you can do the same job with Payoffpaks in an average of five operations. No wonder they are calling this new container "the long-playing record of the wire industry" See how Payoffpaks can pay off for you. Call Continental for complete information on this exciting new way to package, handle and dispense wire.

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A NEW LUBRICATION APPROACH FOR COLD HEADING THRU STRATIFIED LUBRICATION

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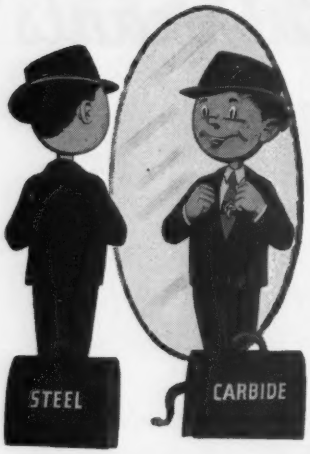

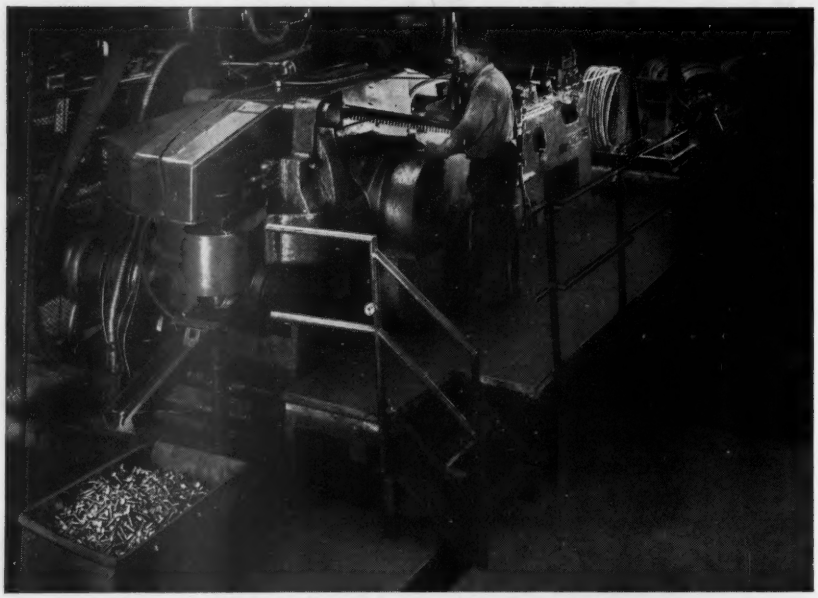

Photo shows automatic bolt maker. Courtesy of Oliver Iron & Steel Corporation.

Mr. Tooley Says:

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How right!

In the field of tools and tooling materials for shaping, forming and removal of metal, Firth Sterling occupies the unique position of supplying *both* steels and carbides to do your job. Thus you *are* always assured of a *bargain* . . . the just-right selection from alternative materials, offered *without bias* from a single source of complete shop tooling.

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C.H.Q. COLD HEADING QUALITY STEEL

- Controlled hardenability by size
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. . . IF IT'S A HIGH PRODUCTION PROBLEM . . .

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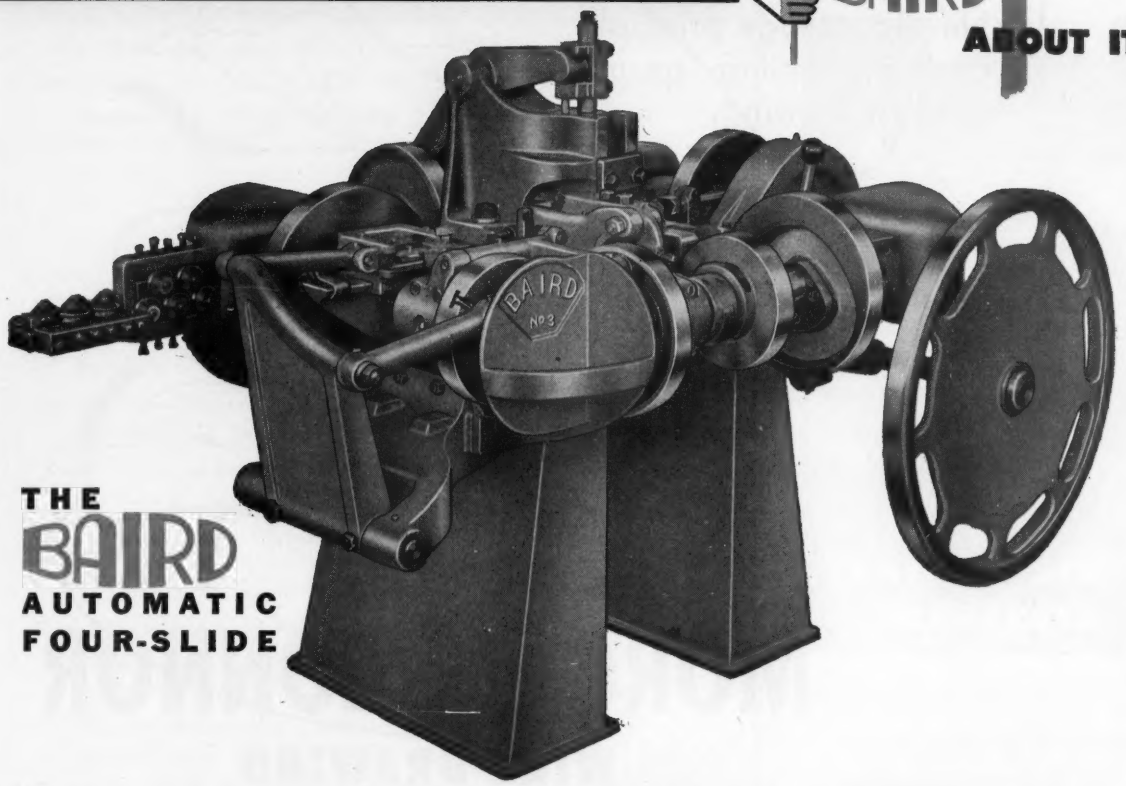

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NO MACHINE IN THE WORLD CAN MAKE A GREATER VARIETY OF PARTS . . . *OR PRODUCE THEM ANY FASTER*

Yet, new wire shapes, formed *by hand,* are continually submitted to us for tooling setups to produce them *automatically* on Baird Four-Slide Machines. We usually solve the problems.

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DRAW IT FAST

No-slip storage principle and air-cooling permit speedy drawing.

DRAW IT COLD

Exclusive air-cooling method removes heat from wire—insures meeting exacting specifications.

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WIRE AND WIRE PRODUCTS*

Reg. U. S. Pat. Off.

A monthly publication devoted to the production of Wire, Rod and Strip, Wire and Rod Products and Insulated Wire and Cable.

DRAWING — ROLLING — EXTRUDING — FORMING — FABRICATING

Vol. 30 July, 1955 No. 7

Designated as Official Publication By The Wire Association

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4 STEP
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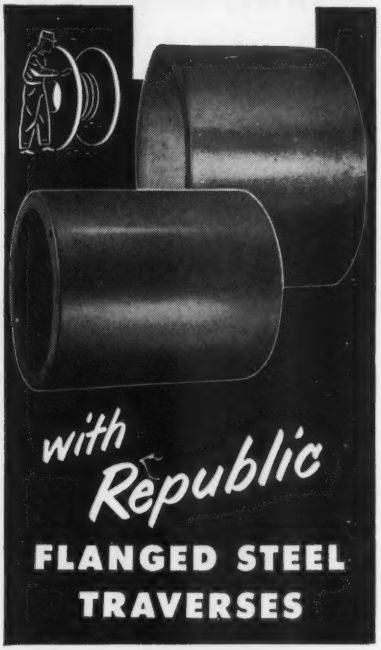
For Wire and Cable Reels



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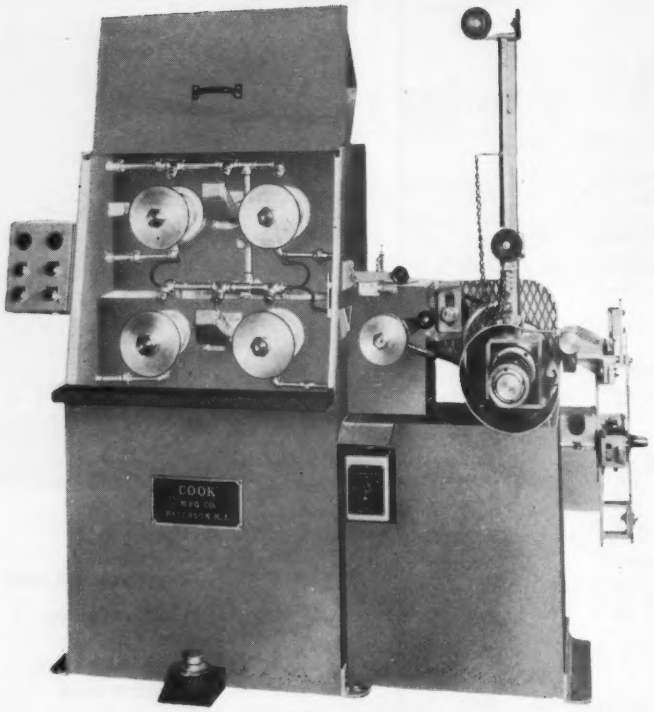

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Motor Size	15 HP
Maximum Spool Capacity	90 lbs.
Spool Flange Diameter	8"
Spool Traverse	6"
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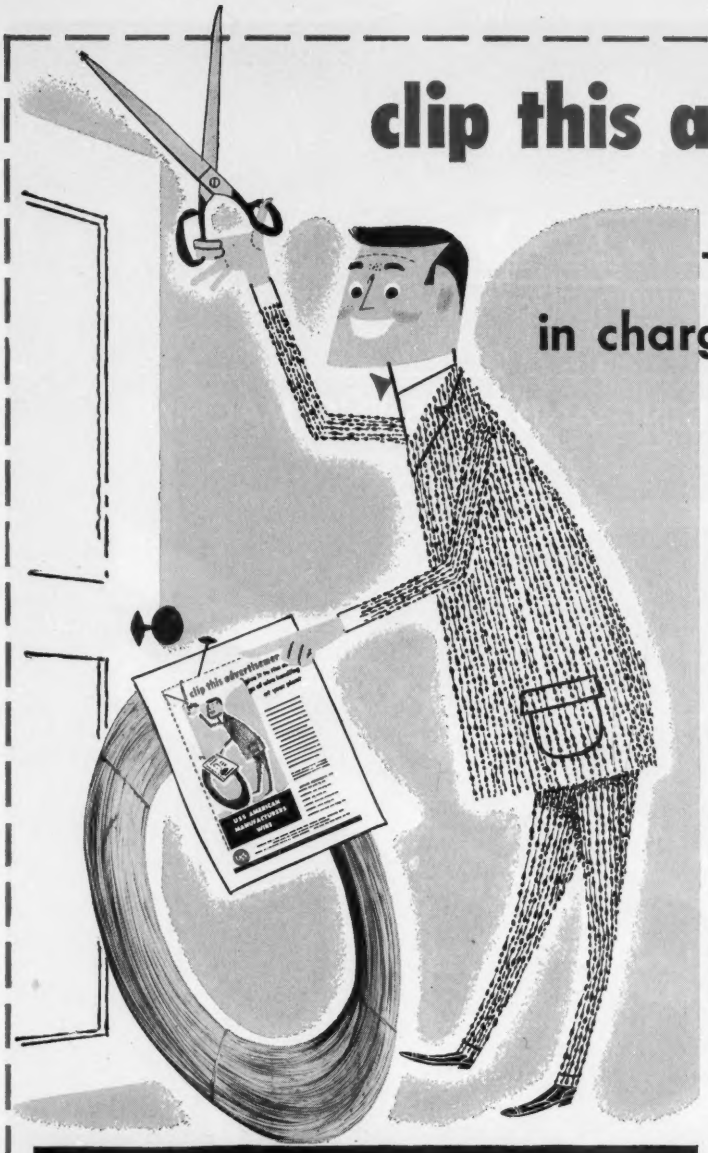

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—give it to the man in charge of wire handling at your plant

Steel wire is one of the trickiest of all materials to handle and store. In fact, this has been a constant problem in our own plants for more than half a century.

So pass this offer along to the man in your plant responsible for the care and handling of wire: American Steel & Wire will be glad to visit your plant and recommend procedures that will save time and money, and lower the blood pressure of the people who have this very tough assignment.

We will also be glad to bring you up to date on the latest industry standards, so you can be sure you are ordering wire in the most economical manner.

Just call your AS&W representative. Tell him you saw this advertisement and want the promised help.

See "THE UNITED STATES STEEL HOUR" —Televised alternate weeks—Consult your newspaper for time and station.

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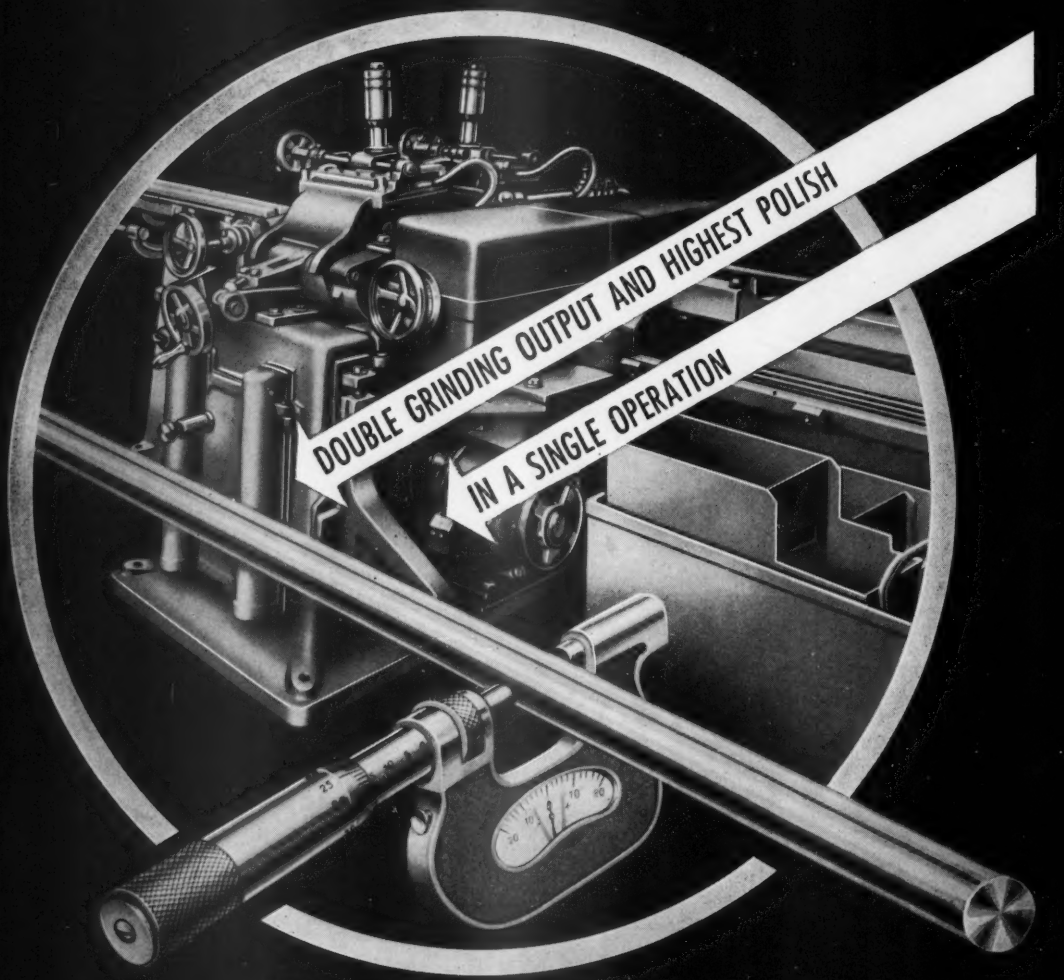

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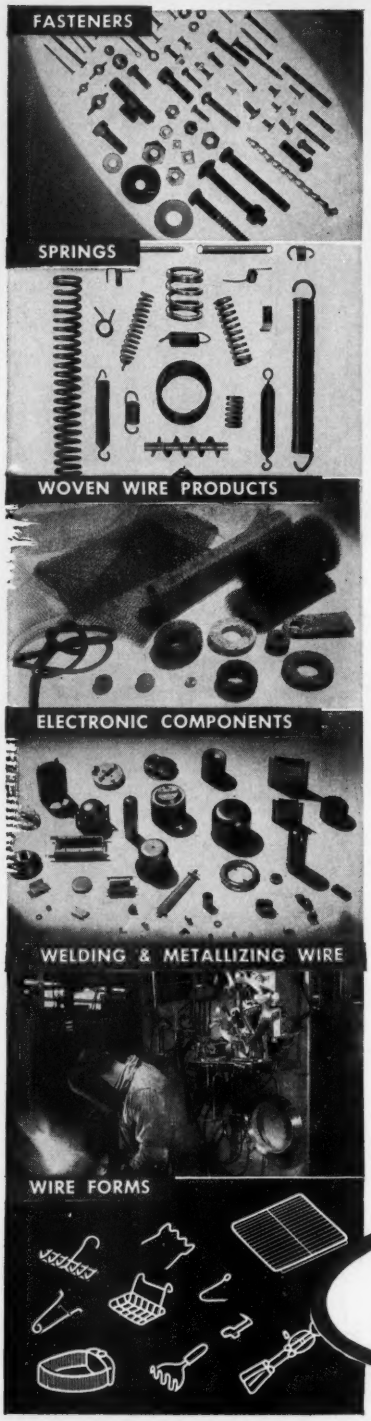

Alloy Wire, Rod and Strip . . .

Design Engineers are taking advantage of the outstanding mechanical and electrical properties and excellent formability of Alloy Wire, Rod and Strip. Results: Better products, smaller and lighter products, products that are more corrosion-resistant, more heat-resistant, more attractive —and more economical.

Alloy Metal Wire Division can supply you with high quality wire, rod and strip in Stainless Steels, Nickel Alloys and Electrical Resistance Alloys. Why not put these versatile materials to work for you?

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FOR A BETTER DESIGN... *Use Wire, Rod, & Strip*

FOR BETTER PRODUCT PERFORMANCE... *Use Alloys*

Among the alloys we fabricate, you will surely find one with just the right combination of properties for your specific application. And you can profit from the fabrication advantages and material cost and weight savings of wire, rod and strip parts and assemblies. Select the alloy you need from these three functional groups:

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Alloy Metal Wire Division can provide you with more than 20 different grades of stainless steels. These include the chromium-nickel Austenitic grades with their outstanding corrosion resistance and good mechanical properties; the high chromium Ferritic grades with their high heat resistance, corrosion resistance, and outstanding cold working properties; and the lower chromium Martensitic grades which can be heat treated to obtain exceptionally high strength and hardness in addition to good resistance to corrosion and high temperatures. Stainless steel Wire, Rod and Strip are used extensively for high strength and corrosion-resistant fasteners, springs and mechanical parts and for welding wire, woven and knitted wire parts, and many other applications.

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F "Maillefer" Extruder, Catalogue 16
G Pay-Off Stand Type VS, Catalogue 13H

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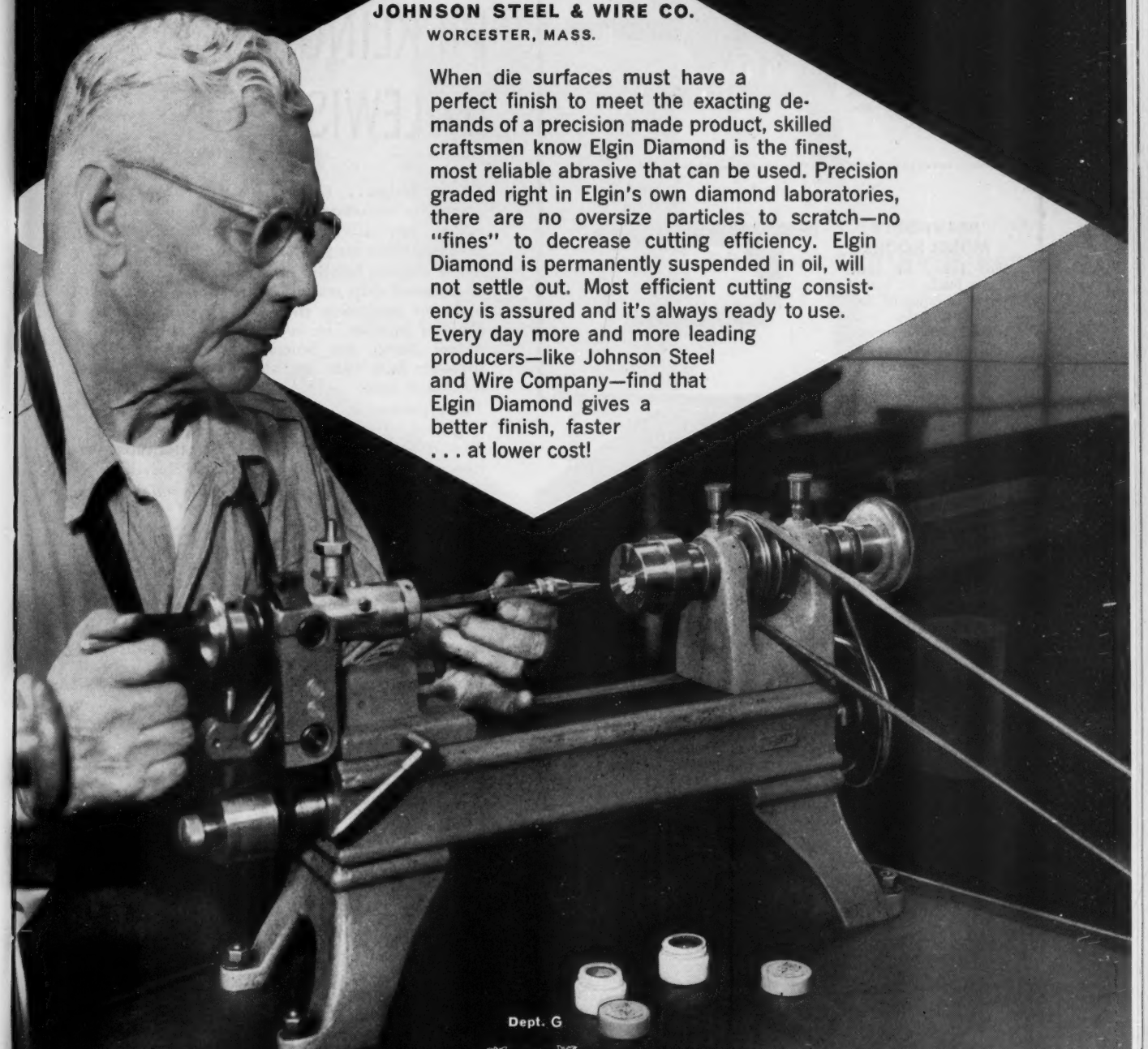

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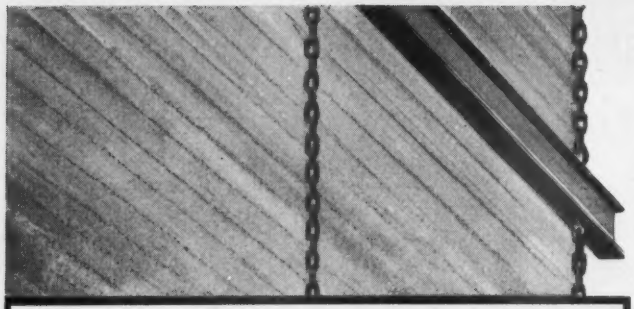

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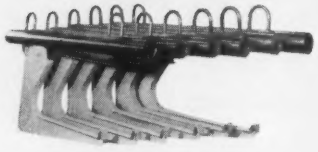
Two types . . . six sizes . . . load capacities up to 4,000 lbs. . . . replaceable steel spreader bars.



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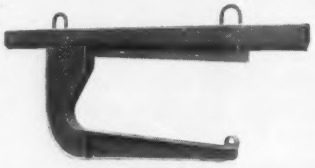
For heavy or extra long loads . . . supplied in range of sizes and capacities with steel or Monel spreader bars.



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These durable hairpin hooks feature a specially-designed drip trough on the load bar that picks up condensate and carries it out beyond the rod bundles. In addition, the all-welded Monel hooks are bolted to low-cost steel spreader bars that are easily replaceable at minimum cost.

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There's room for greater profits

...with the NEW Torrington W3001

TORSION SPRING WINDER

Room — room in which to work — is the outstanding feature of Torrington's new torsion spring winder. This modern, high production machine actually provides the largest tooling area ever devised. In addition, the W3001 offers many other advantages which will help spring-makers boost their production of torsion springs and reduce their costs at the same time.

• Tooling area measures 12" by 18" • Tooling is faster and easier • Tools themselves can be made sturdier and more durable • Shafts on 3 sides plus vertical 2-slide attachment give great versatility in producing complex forms • Capacity extends to 10 turns of .080" wire, thus meeting the great majority of customer requirements for torsion springs • Rugged design means years of trouble-free operation with minimum downtime for maintenance and repairs.

The Torrington Manufacturing Company has built more spring coiling machinery since 1937 than all other manufacturers combined. The knowledge and skill gained while serving spring makers during this period has now been used to create a torsion winder which we firmly believe is the finest ever offered to the industry. If you manufacture torsion springs, this new machine will give you faster, more efficient production and unprecedented versatility to meet your customers' most exacting needs.

Call or write, *now,* for full information.

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MANUFACTURING COMPANY
TORRINGTON · CONNECTICUT
WIRE FORMING MACHINERY DIVISION

DESIGNED FOR CUSTOMER APPEAL

NEW IMPROVED

ALUMINUM SPOOLS

NEW IMPROVED

LIGHTWEIGHT • LOW SHIPPING COSTS
RIGID CONSTRUCTION • BALANCED

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Check with *HUBBARD* for your spool needs.

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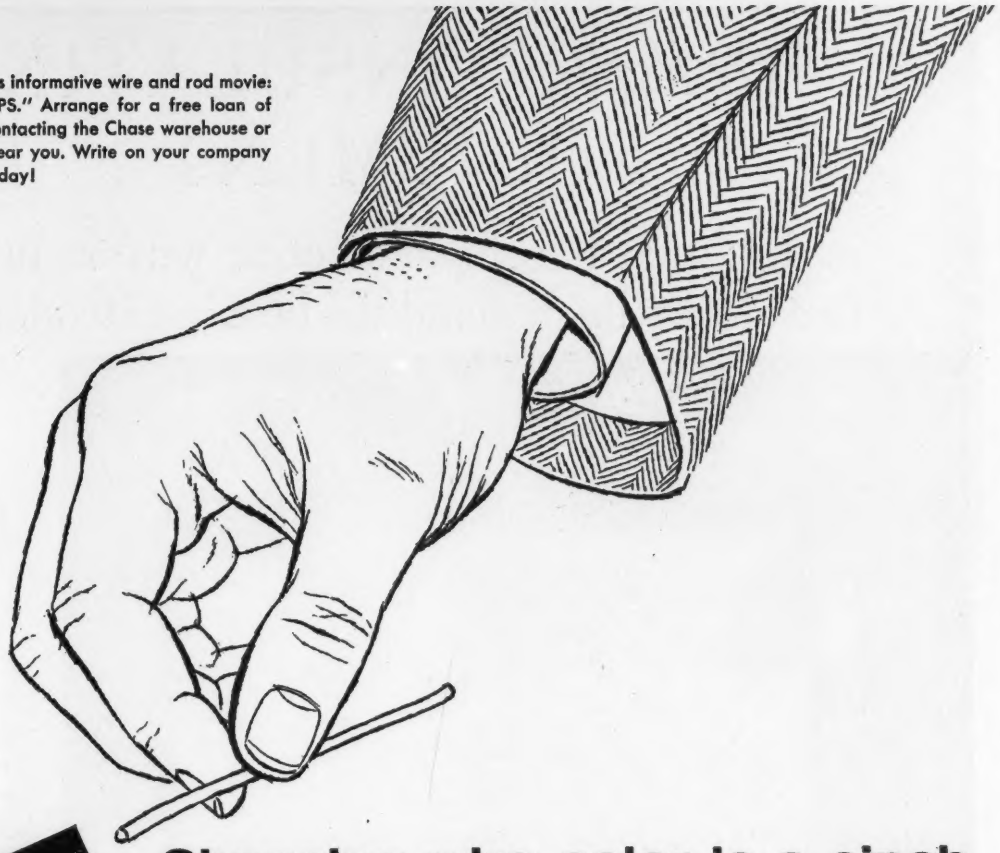

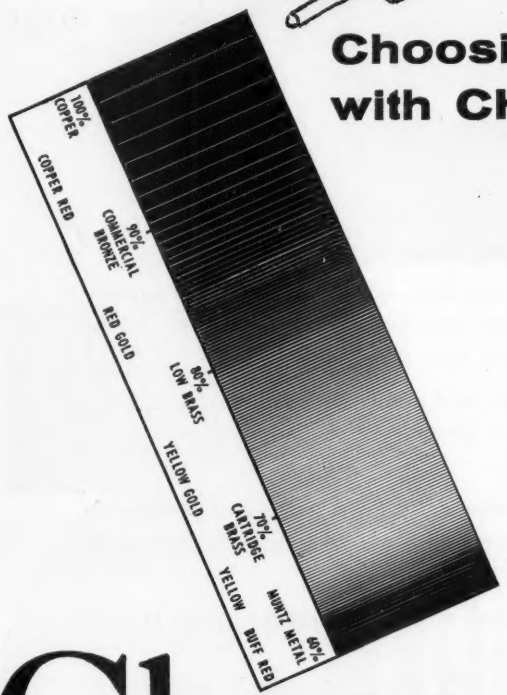

Choosing wire color is a cinch with CHASE® on the job for you!

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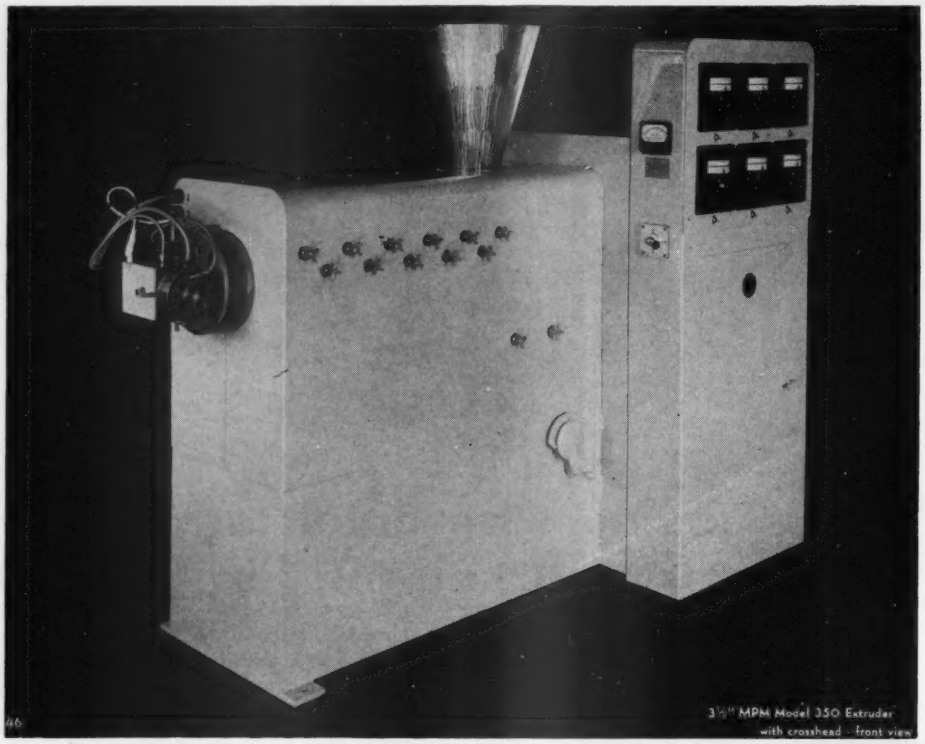

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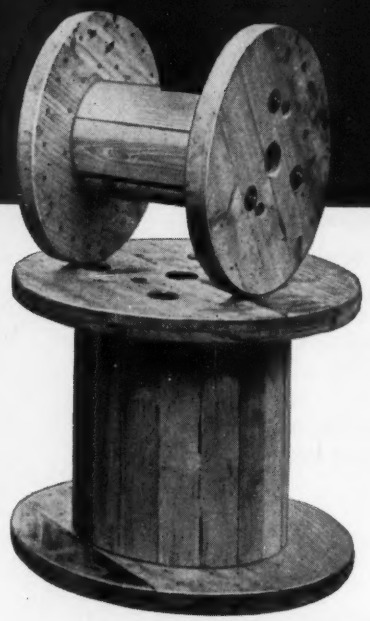

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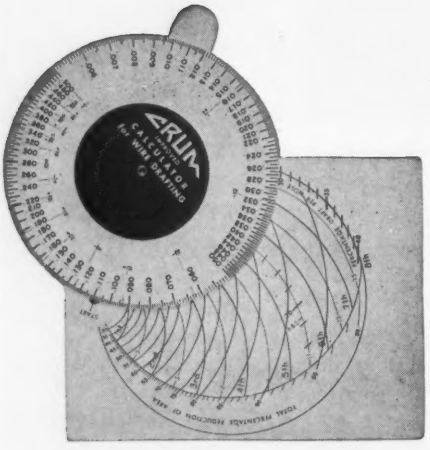

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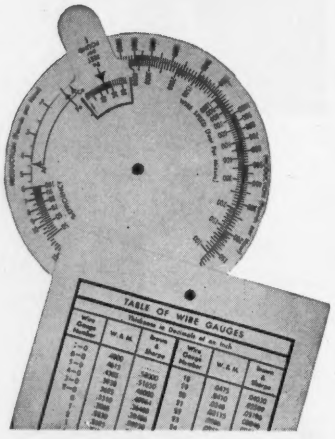

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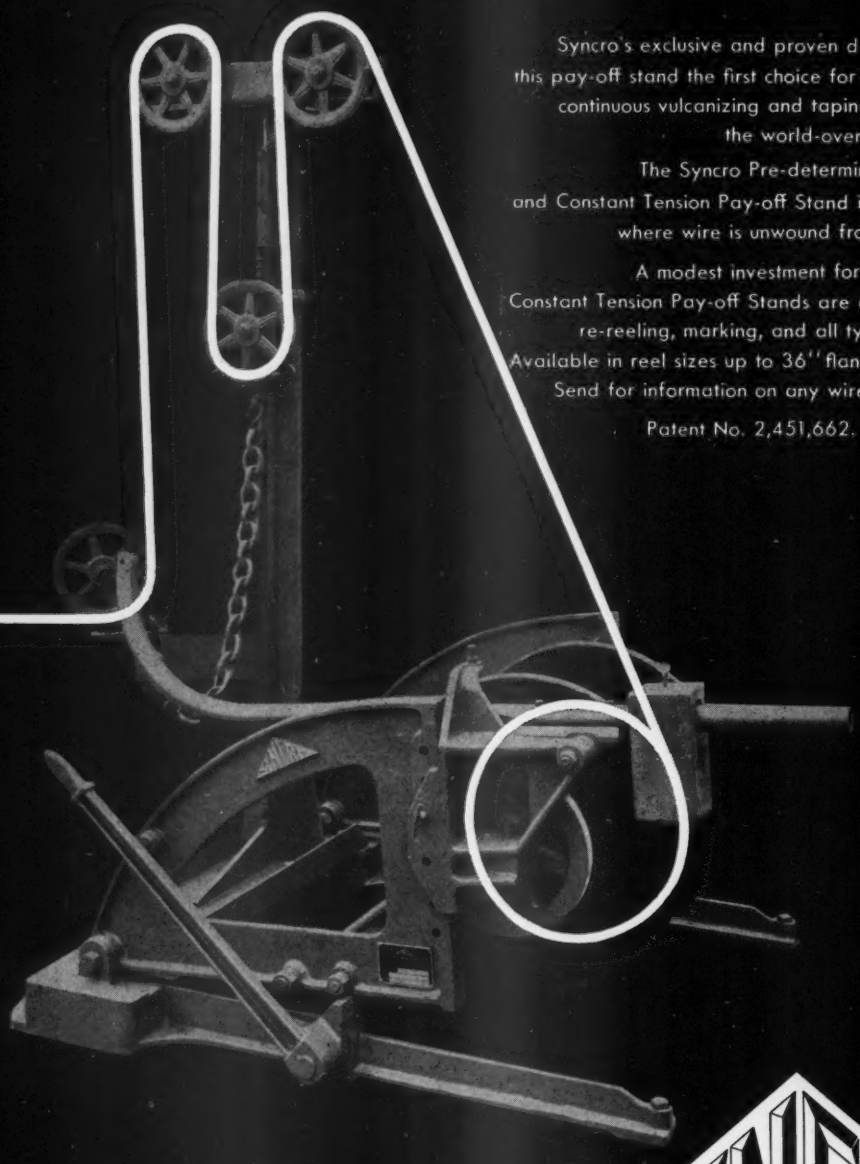

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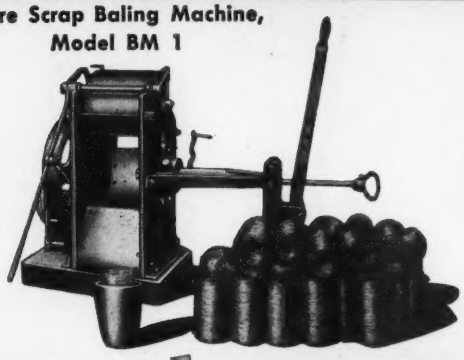

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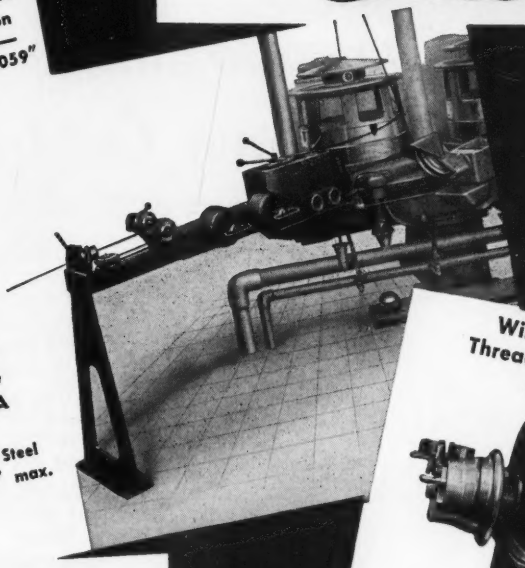

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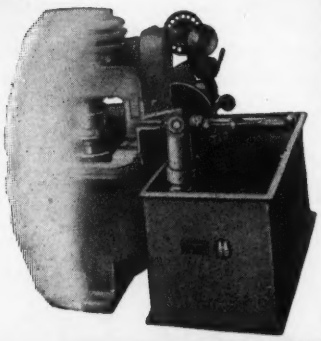

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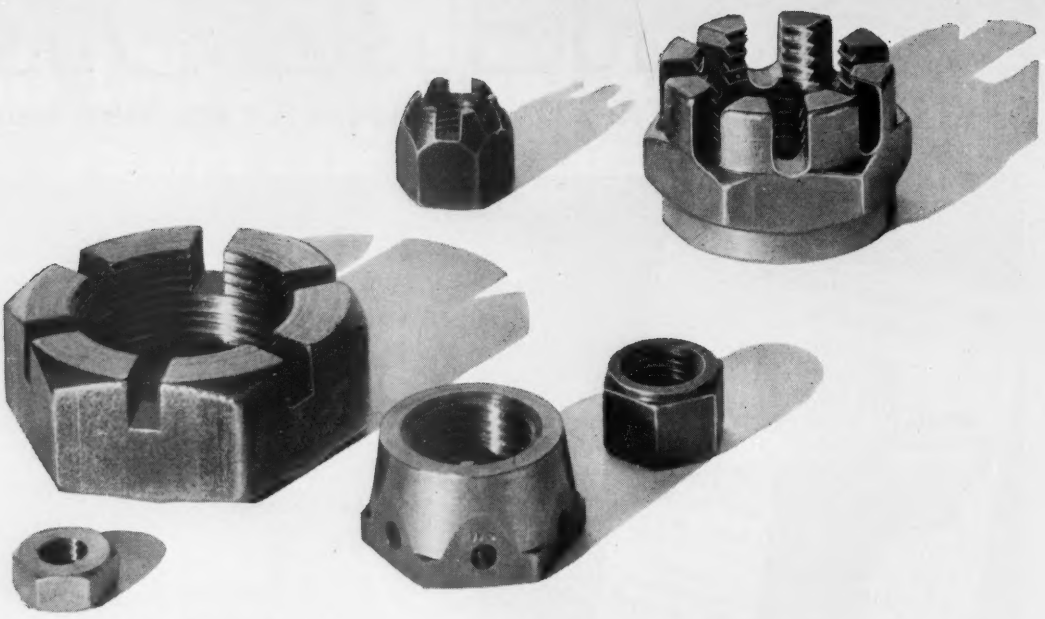

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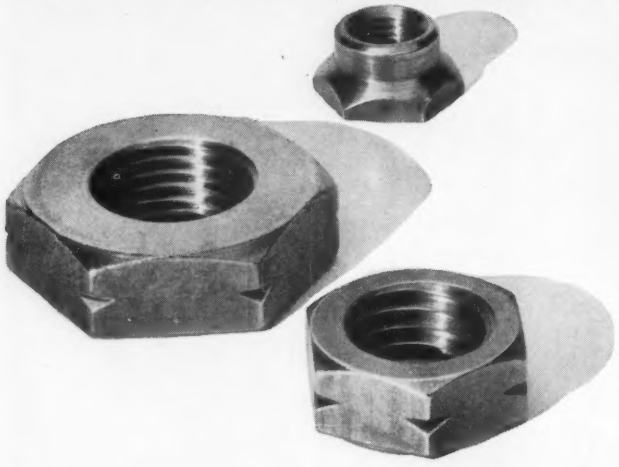

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The Wire Outlook

A leveling off of business, but with a continuation of the present high rates of activity is forecast. The best thing that can be said about this cycle in which we are operating is that it contains only mild inflationary elements, other than that of meeting the demands of consumers.

It could get out of hand, of course, but this is not a strong probability, unless some new forces are injected into the economy of which we are not presently aware. Growth will continue gradually as population increases. Wages and costs will continue their small, but steady spiral. A 500 million dollar national income is visualized by the end of the next decade.

May was considered a banner month by both the Department of Commerce and the NAPA. Production gains were recorded and new orders were estimated to be 54% higher than in April. Higher investment demand and strong consumer spending is keeping business good. Motor car production has passed its peak for the year and the industry now will have to struggle with its guaranteed wage problem, even though the danger of strikes seems to have passed with the settlement of the Ford contract. But the upsurge in machinery production, the high rates of building construction and the growing demand for steel would have somewhat offset any automotive shutdowns, it is believed. There will be the usual slowing up of business during the Summer, although it will pick up when the hot, vacation season is over.

A tide of conservatism appears to be sweeping the world. The latest evidence is Eden's smashing victory in England. The trend started in Australia in 1949, was followed by Churchill's election in 1950, the Eisenhower election in 1952 and the Adenauer victory over socialism in 1952. Corresponding to this are reports of growing weakness and unrest in Red dominated countries, which may account for the milder and more peaceful tone of the Communist leaders.

Contrary to what the political "outs" would have people believe, conservatism does not necessarily mean lack of progress. It actually stands for common sense and honesty, both in business and government, with considerably more real progress possible than under those regimes that would rob Peter to pay Paul. The policies from which we suffered for so long were not progressive, but retrogressive. Socialistic schemes have been tried countless times, been found wanting and actually brought about the downfall of many a once prosperous nation.

The demand for non-ferrous metals continues unabated. The copper situation is better because of the release of some metal from stockpiles and due to the peaceful settlement of a number of copper mine labor disputes. About 2,000,000 pounds of nickel was released in June for industry, making a total of 3 million pounds recently channeled to private users. More aluminum is going to non-integrated plants, but the rapid increase in demand may bring about consideration of a government—aided third round of expansion. Lead and zinc demand continues to pile up, with plenty available, however.

There has been a slight easing in the demand for merchant wire, with some mills feeling that this is a below-normal year, while others are operating at capacity. This involves fencing, netting, bale ties and the like.

Bars, rods, wire and oil field supplies are moving well, with spring wire in excellent demand. Cable and guard cable, as well as reinforcing wire mesh, are selling actively. Nail demand is so good that there has been little opportunity for inventory building. Manufacturers' wire is finding a willing market, but fine wire sizes are not keeping pace with the demand for coarser sizes. The automotive, appliance and bedding industries are among the heaviest buyers of wire.

While we are not concerned primarily with hanging up of new records, it is gratifying to observe what can be done under the stimulus of confidence.

—from the Editor's Desk

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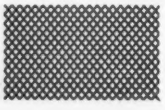

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Vol. 30 JULY, 1955 No. 7

Some Bending Characteristics of Cartridge Brass, 70%, and Yellow Brass, 65%, Wire

by
Messrs. Lewis E. Thelin and Robert O. Abbott, Jr.
Assistant Chief Metallurgist Assistant General Foreman
Bristol Brass Corporation
Bristol, Connecticut

The Authors presented this paper at the New York Regional Meeting of The Wire Association on April 28, 1955, in the Non-Ferrous Section meeting.

In view of the large tonnage of copper-base alloy wire used for formed or bent products, the authors believed that a study of the bending characteristics of several of the commonly used alloys would warrant investigation. To the best of our knowledge, no one has compiled and published data relative to the bending characteristics of the most widely used copper-base alloys in wire form, when bent under conditions simulating forming in single or multi-slide machines. A considerable amount of data has been published on the bending characteristics of these alloys in strip form, but this, it was felt, could not be converted as applicable to wire when formed in slide machines.

★ ★ ★

Figure 1 illustrates a few parts of the type formed from wire and which are commonly produced from copper-base alloy wire are representative of those produced on multi-slide machines.

★ ★ ★

It was an additional hope of the authors that the data when collected could be presented in a form that would be of assistance to both metallurgists and tool designers in the selection of suitable temper wire for formed parts and possibly give an indication of the "spring-back", or set for use, when designing bending dies.

Figure 1.

★ ★ ★

To these ends, the authors conceived and constructed a bending test device or brake patterned after the simple slide benders used in commercial production. Using this device, tests were conducted to determine the relative bending characteristics of Cartridge Brass, 70%, and Yellow Brass, 65%. These two alloys being selected by virture of their accounting for the major percentage of the brass alloy wire used for formed parts.

★ ★ ★

Figures 2 and 3 show the device as constructed and will be self-explanatory to those familiar with wire bending.

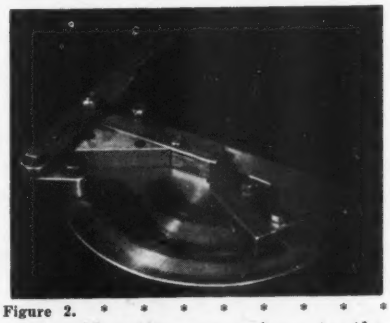


Figure 2.

Consideration was given to the possible variables affecting the bending characteristics of wire, and the following were believed effective:

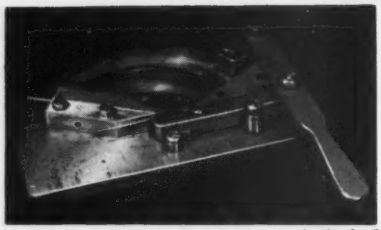


Figure 3.

1. Temper draw (% final reduction)
2. Alloy composition
3. Prior thermal treatment (Finish or "ready") grain size
4. Prior processing treatment
5. Rate of bending
6. Lubrication
7. Surface finish
8. Gauge or diameter

★ ★ ★

For purposes of simplicity it was decided to eliminate as many as possible of the variables, and believed that by using a constant gauge wire, no lubrication, carbide draw dies, and wire processed using standard mill procedure, we would restrict our variables to:

a. Temper draw (% final reduction)
b. Finish or "ready" grain sizes
c. Alloy composition

★ ★ ★

We had prepared, using one cast billet each in order to minimize the effect of chemical composition, coils of wire to finish on 0.064," round diameter, from a variety of "ready" gauges.

★ ★ ★

The effect of the ultimate annealing treatment or "ready" grain size on the bending characteristics was considered by having each temper finish drawn from each of three standard nominal grain size ranges, namely 0.015mm, 0.35mm, and 0.050mm.

★ ★ ★

The test gauge of 0.064" diameter was selected after discussion with several major producers of formed wire parts, as being one that would be representative of a large percentage of their production.

★ ★ ★

Serious consideration was given to adding the effect of lubrication to this study, but was eliminated due to the variety of lubricants in common commercial usage.

The basic procedure used in the conduction of this investigation was as follows:

(a) Billets for hot extrusion were cast and analyzed for their conformance to the requirements of A.S.T.M. Spec. B134-52, alloys Nos. 6 and 7.

(b) Using standard mill practice, these billets were extruded and redrawn to the largest "ready" diameter used (0.160") and were re-checked for chemical composition.

★ ★ ★

The mill procedure used in producing the test coils was similiar to that used in the regular production of similar alloys and tempers for commercial wire.

★ ★ ★

The Cartridge Brass, 70%, wire was extruded using a 6-½" diameter billet, 26" long, through a 3/4" diameter single hole die. After the elimination of pipe scrap the coils were processed on a Farrel 12 Stand Roll to 0.256" square. Annealed at 1050°F. for 3-1/4 hours resulting in an approximate 0.070mm. grain size.

★ ★ ★

The next breakdown was done on a Syncro Wire machine to the desired "ready to finish" gauge. The "ready to finish" reduction was held to approximately 50% in all cases. The finish draws were done on single hole blocks in order to eliminate the costly set-up time that would be involved in a multi-die machine.

★ ★ ★

The procedure used in producing the Yellow Brass, 65%, wire was similar except that a cast billet 7-½" diameter and 26" long was utilized.

(c) Each coil on its "ready to finish" gauge was annealed at three different temperatures and tested to insure conformity to the grain size ranges desired.

(d) Using Carbide dies, one coil each of the desired "ready" gauge and alloy were drawn to 0.064" round diameter, using a suitable intermediate reduction.

(e) At this stage, each coil was tested for tensile strength, re-checked for its approximate grain size, and analyzed for chemical composition to insure conformity to specification and to the temper desired. Table #1 shows the results of test analysis made on each billet and confirmed by subsequent re-analysis.

(f) A minimum of three samples from each temper and "ready" grain size were bend tested using two different radii, namely, one-half the wire diameter (0.032") and sharp or no radius. The no radius jaws were machined to a sharp edge and the edge just broken by use of a honing stone. Bends of 30°, 60°, 90°, 120°, and 150°, were made on each sample and held for macroscopic inspection and "spring-back" or set measurements.

(g) Each sample, after bending, was examined macroscopically and evaluated as O.K. or fractured.

★ ★ ★

The angle of each sample, after bending, was measured by means of a protractor and the angular measurement to the nearest degree recorded as "set", after subtraction of the basic angle of bend.

★ ★ ★

(h) Any series of tests which contained one or more contradictory values or observations, were duplicated until adequate duplication of results were assured. All data recorded is the average of at least three determinations.

★ ★ ★

Figure 4 below, shows one typical series of samples, after bending, and prior to observing the bend quality and measuring the "spring-back."

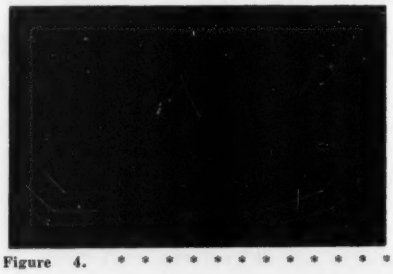


Figure 4.

For simplicity's sake all test data is presented in tabulated form. Graphical representation was not offered as the authors could not anticipate the various individual desires or parts of the data required. Tables numbered 2 to 10 inclusive, contain the test data recorded.

★ ★ ★

The data presented leads to the following observations and conclusions:

TABLE #1

Chemical Composition

Alloy	Catridge Brass, 70%	Yellow Brass, 65%
Analysis		
Copper	70.20%	65.60%
Lead	0.01	0.02
Iron	0.01	0.01
Nickel	none	none
Tin	none	none
Zinc	remainder	remainder

TABLE #2

Finish Wire Size - .064" - drawn from .068" - 1/2# Hard (11.5% red.)

Sample Number	Alloy	Grain Size (ready)	Tensile
1	65/35	.015 mm	65,400 psi
2	65/35	.035 mm	62,400 psi
3	65/35	.065 mm	59,800 psi
4	70/30	.015 mm	66,700 psi
5	70/30	.045 mm	60,900 psi
6	70/30	.055 mm	60,800 psi

Upper values denote bending radius equal to 1/2 wire diameter.
Lower values denote bending radius equal to .000".

Sample Number	30° Bend	60° Bend	90° Bend	120° Band	150° Bend
1	OK-4° set	OK-2° set	OK-4° set	OK-3° set	OK-3° set
	OK-3° set	OK-2° set	OK-5° set	OK-3° set	OK-1° set
2	OK-4° set	OK-2° set	OK-4° set	OK-3° set	OK-3° set
	OK-3° set	OK-2° set	OK-4° set	OK-3° set	OK-1° set
3	OK-4° set	OK-1° set	OK-4° set	OK-2° set	OK-3° set
	OK-3° set	OK-2° set	OK-3° set	OK-2° set	OK-2° set
4	OK-4° set	OK-2° set	OK-4° set	OK-3° set	OK-3° set
	OK-3° set	OK-2° set	OK-4° set	OK-2° set	OK-1° set
5	OK-4° set	OK-1° set	OK-3° set	OK-2° set	OK-2° set
	OK-4° set	OK-2° set	OK-3° set	OK-1° set	OK-1° set
6	OK-3° set	OK-2° set	OK-3° set	OK-3° set	OK-2° set
	OK-3° set	OK-2° set	OK-3° set	OK-2° set	OK-1° set

TABLE #3

Finish Wire Size - .064" - drawn from .072" - 1# Hard (21% red)

Sample Number	Alloy	Grain Size (ready)	Tensile
7	65/35	.015 mm	74,800 psi
8	65/35	.035 mm	72,300 psi
9	65/35	.065 mm	69,200 psi
10	70/30	.020 mm	73,900 psi
11	70/30	.045 mm	70,100 psi
12	70/30	.065 mm	69,500 psi

Upper values denote bending radius equal to 1/2 wire diameter.
Lower values denote bending radius equal to .000".

Sample Number	30° Bend	60° Bend	90° Bend	120° Bend	150° Bend
7	OK - 4° set	OK - 3° set	OK - 4° set	OK - 4° set	OK - 3° set
	OK - 4° set	OK - 2° set	OK - 5° set	OK - 3° set	OK - 2° set
8	OK - 4° set	OK - 2° set	OK - 4° set	OK - 4° set	OK - 3° set
	OK - 4° set	OK - 1° set	OK - 5° set	OK 4° set	OK - 1° set
9	OK - 4° set	OK - 2° set	OK - 4° set	OK - 3° set	OK - 4° set
	OK - 4° set	OK - 1° set	OK - 3° set	OK - 1° set	OK - 1° set
10	OK - 3° set	OK - 2° set	OK - 4° set	OK- 3° set	OK - 3° set
	OK - 4° set	OK - 1° set	OK - 5° set	OK - 2° set	OK - 1° set
11	OK - 3° set	OK - 1° set	OK - 3° set	OK - 2° set	OK - 3° set
	OK - 4° set	OK - 1° set	OK - 3° set	OK - 3° set	OK - 2° set
12	OK - 3° set	OK - 2° set	OK - 2° set	OK - 2° set	OK - 3° set
	OK - 4° set	OK - 1° set	OK - 4° set	OK - 1° set	OK - 1° set

TABLE #4

Finish Wire Size - .064" - drawn from .080" - 2# Hard (36% red.)

Sample Number	Alloy	Grain Size (ready)	Tensile
13	65/35	.015 mm	89,500 psi
14	65/35	.035 mm	87,600 psi
15	65/35	.065 mm	84,100 psi
16	70/30	.015 mm	88,800 psi
17	70/30	.045 mm	86,400 psi
18	70/30	.065 mm	85,700 psi

Upper values denote bending radius equal to 1/2 wire diameter.
Lower values denote bending radius equal to .000".

Sample Number	30° Bend	60° Bend	90° Bend	120° Bend	150° Bend
13	OK - 4° set	OK - 2° set	OK - 4° set	OK - 3° set	OK - 4° set
	OK - 5° set	OK - 4° set	OK - 6° set	OK - 5° set	OK - 3° set
14	OK - 3° set	OK - 2° set	OK - 4° set	OK - 4° set	OK - 4° set
	OK - 4° set	OK - 4° set	OK - 6° set	OK - 5° set	OK - 5° set
15	OK - 2° set	OK - 2° set	OK - 3° set	OK - 4° set	OK - 3° set
	OK - 5° set	OK - 3° set	OK - 6° set	OK - 5° set	OK - 5° set
16	OK - 2° set	OK - 2° set	OK - 3° set	OK - 4° set	OK - 2° set
	OK - 6° set	OK - 5° set	OK - 7° set	OK - 3° set	OK - 3° set
17	OK - 3° set	OK - 3° set	OK - 3° set	OK - 3° set	OK - 1° set
	OK - 6° set	OK - 5° set	OK - 6° set	OK - 3° set	OK - 2° set
18	OK - 3° set	OK - 3° set	OK - 3° set	OK - 4° set	OK - 2° set
	OK - 6° set	OK - 6° set	OK - 6° set	OK - 2° set	OK - 1° set

TABLE #5

Finish Wire Size - .064" - Drawn From .090" -3# Hard. (49.5% red.)

Sample Number	Alloy	Grain Size (ready)	Tensile
19	65/35	.015 mm	98,200 psi
20	65/35	.040 mm	97,200 psi
21	65/35	.060 mm	96,400 psi
22	70/30	.020 mm	101,000 psi
23	70/30	.045 mm	98,800 psi
24	70/30	.060 mm	96,700 psi

Upper values denote bending radius equal to 1/2 wire diameter.
Lower values denote bending radius equal to .000".

Sample Number	30° Bend	60° Bend	90° Bend	120° Bend	150° Bend
19	OK - 5° set	OK - 3° set	OK - 5° set	OK - 5° set	OK - 5° set
	OK - 7° set	OK - 4° set	OK - 6° set	OK - 4° set	OK - 3° set
20	OK - 4° set	OK - 3° set	OK - 4° set	OK - 5° set	OK - 5° set
	OK - 7° set	OK - 4° set	OK - 7° set	OK - 4° set	OK - 3° set
21	OK - 4° set	OK - 2° set	OK - 4° set	OK - 5° set	OK - 5° set
	OK - 7° set	OK 3° set	OK - 6° set	OK - 4° set	OK - 3° set
22	OK - 4° set	OK - 2° set	OK - 4° set	OK - 5° set	OK - 5° set
	OK - 7° set	OK - 5° set	OK 6° set	OK - 4° set	OK - 4° set
23	OK - 5° set	OK - 2° set	OK - 4° set	OK - 5° set	OK - 5° set
	OK - 7° set	OK - 4° set	OK - 6° set	OK - 3° set	OK - 3° set
24	OK - 5° set	OK 1° set	OK - 3° set	OK - 5° set	OK - 5° set
	OK - 6° set	OK - 4° set	OK - 6° set	OK - 2° set	OK - 2° set

TABLE # 6

Finish Wire Size - .064" - drawn from .102" - 4# Hard (60.5% red.)

Sample Number	Alloy	Grain Size (ready)	Tensile
25	65/35	.015 mm	112,600 psi
26	65/35	.035 mm	110,000 psi
27	65/35	.065 mm	108,500 psi
28	70/30	.015 mm	113,400 psi
29	70/30	.035 mm	111,300 psi
30	70/30	.060 mm	109,400 psi

Upper values denote bending radius equal to 1/2 wire diameter.

Lower values denote bending radius equal to .000".

Sample Number	30° Bend	60° Bend	90° Bend	120° Bend	150° Bend
25	OK - 3° set	OK - 4° set	OK - 5° set	OK - 7° set	Fracture
	OK - 5° set	OK - 6° set	OK - 8° set	Fracture	Fracture
26	OK - 3° set	OK - 4° set	OK - 6° set	OK - 7° set	OK - 8° set
	OK - 5° set	OK - 5° set	OK - 7° set	Fracture	Fracture
27	OK - 3° set	OK - 3° set	OK - 6° set	OK - 6° set	OK - 7° set
	OK - 5° set	OK - 5° set	OK - 7° set	Fracture	Fracture
28	OK - 3° set	OK - 3° set	OK - 5° set	OK - 7° set	OK - 9° set
	OK - 6° set	OK - 6° set	OK - 7° set	Fracture	Fracture
29	OK - 2° set	OK - 3° set	OK - 6° set	OK - 7° set	OK - 9° set
	OK - 5° set	OK - 6° set	OK - 7° set	Fracture	Fracture,
30	OK - 3° set	OK - 3° set	OK - 6° set	OK - 10° set	OK - 12° set
	OK - 5° set	OK - 6° set	OK - 7° set	Fracture	Fracture

TABLE # 7

Finish Wire Size - .064" - drawn from .114" - 5# Hard (68.5% red.)

Sample Number	Alloy	Grain Size (ready)	Tensile
31	65/35	.015 mm	115,700 psi
32	65/35	.035 mm	114,400 psi
33	65/35	.070 mm	113,500 psi
34	70/30	.015 mm	117,600 psi
35	70/30	.040 mm	116,300 psi
36	70/30	.060 mm	116,000 psi

Upper values denote bending radius equal to 1/2 wire diameter.
Lower values denote bending radius equal to .000".

Sample Number	30° Bend	60° Bend	90° Bend	120° Bend	150° Bend
31	OK - 5° set	OK - 5° set	OK - 7° set	OK - 11° set	fracture
	OK - 7° set	OK - 6° set	fracture	fracture	fracture
32	OK - 5° set	OK - 6° set	OK - 6° set	OK - 9° set	Fracture
	OK - 7° set	OK - 6° set	Fracture	Fracture	Fracture
33	OK - 7° set	OK - 7° set	OK - 6° set	Fracture	Fracture
	OK - 7° set	OK - 7° set	OK - 8° set	Fracture	Fracture
34	OK - 6° set	OK - 6° set	OK - 6° set	Fracture	Fracture
	OK - 8° set	OK - 7° set	OK - 7° set	Fracture	Fracture
35	OK - 5° set	OK - 8° set	OK - 6° set	Fracture	Fracture
	OK - 8° set	OK - 7° set	OK - 8° set	Fracture	Fracture,
36	OK - 5° set	OK - 8° set	OK - 6° set	OK - 10° set	Fracture
	OK - 6° set	OK - 7° set	OK - 8° set	Fracture	Fracture

TABLE #8

Finish Wire Size - .064" - drawn from .128" - 6# Hard (75% red.)

Sample Number	Alloy	Grain Size (ready)	Tensile
37	65/35	.015 mm	120,700 psi
38	65/35	.040 mm	119,700 psi
39	65/35	.065 mm	119,300 psi
40	70/30	.025 mm	123,000 psi
41	70/30	.050 mm	122,800 psi
42	70/30	.065 mm	121,500 psi

Upper values denote bending radius equal to 1/2 wire diameter.
Lower values denote bending radius equal to .000".

Sample Number	30° Bend	60° Bend	90 Bend	120° Bend	150° Bend
37	OK - 5° set	OK - 9° set	OK - 6° set	Fracture	Fracture
	OK - 7° set	OK - 10° set	Fracture	Fracture	Fracture
38	OK - 5° set	OK - 9° set	OK - 6° set	Fracture	Fracture
	OK - 6° set	OK - 10° set	Fracture	Fracture	Fracture
39	OK - 6° set	OK - 9° set	Fracture	Fracture	Fracture
	OK - 7° set	OK - 7° set	Fracture	Fracture	Fracture
40	OK - 10° set	OK - 6° set	OK - 8° set	Fracture	Fracture
	OK - 8° set	OK - 7° set	OK - 9° set	Fracture	Fracture
41	OK - 8° set	OK - 6° set	Fracture	Fracture	Fracture
	OK - 7° set	OK - 8° set	Fracture	Fracture	Fracture
42	OK - 7° set	OK - 5° set	OK - 5° set	Fracture	Fracture
	OK - 7° set	OK - 6° set	Fracture	Fracture	Fracture

TABLE # 9

Finish Wire Size - .064" - drawn from .143" - 7# Hard (80% red.)

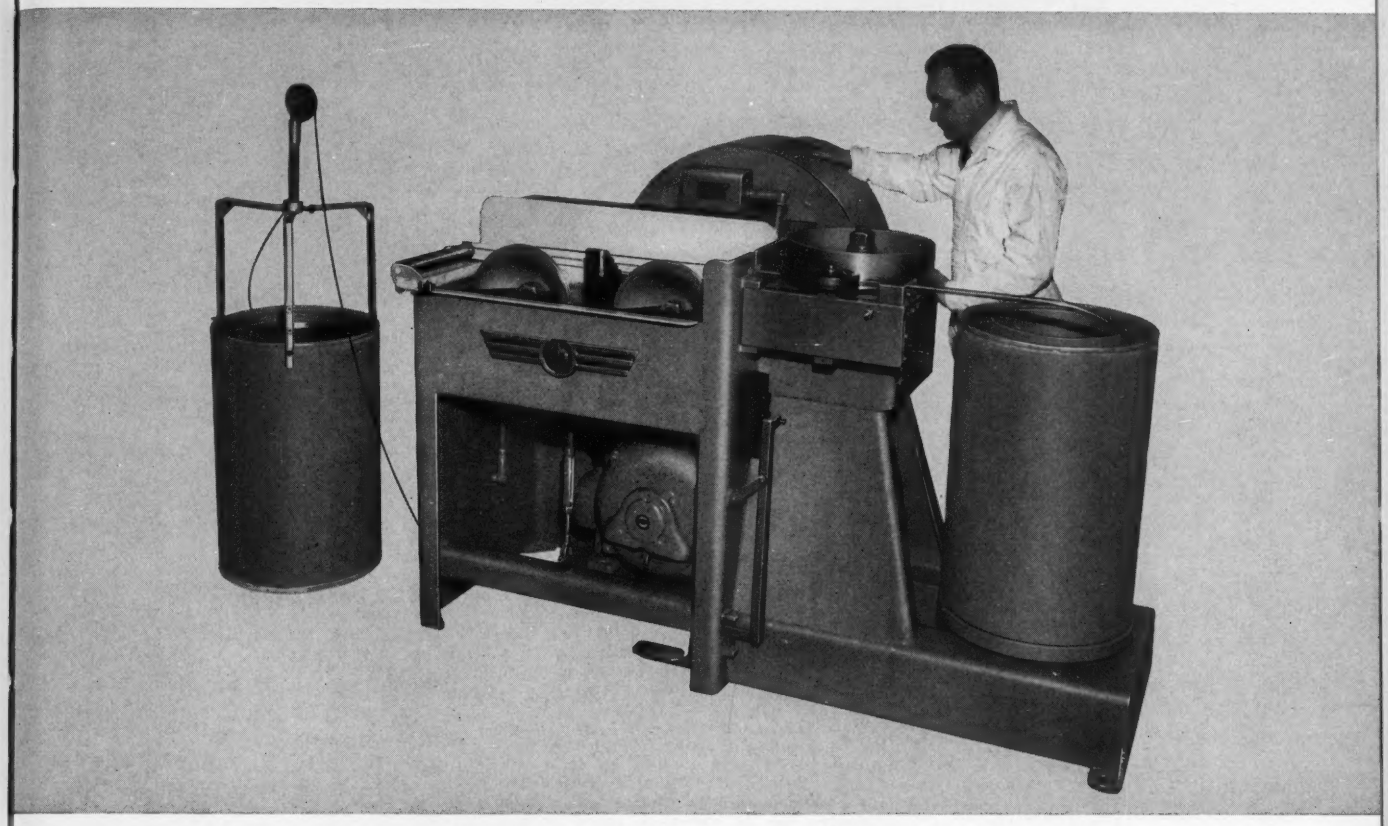
Sample Number	Alloy	Grain Size (ready)	Tensile
43	65/35	.015 mm	126,200 psi
44	65/35	.035 mm	123,200 psi
45	65/35	.065 mm	121,300 psi
46	70/30	.015 mm	127,300 psi
47	70/30	.040 mm	126,000 psi
48	70/30	.060 mm	123,000 psi

Upper values denote bending radius equal to 1/2 wire diameter.
Lower values denote bending radius equal to .000".

Sample Number	30° Bend	60° Bend	90° Bend	120° Bend	150° Bend
43	OK - 11° set	OK - 6° set	Fracture	Fracture	Fracture
	OK - 10° set	OK - 7° set	Fracture	Fracture	Fracture
44	OK - 9° set	OK - 8° set	Fracture	Fracture	Fracture
	OK - 9° set	OK - 9° set	Fracture	Fracture	Fracture
45	OK - 5° set	OK - 5° set	Fracture	Fracture	Fracture
	OK - 6° set	OK - 6° set	Fracture	Fracture	Fracture
46	OK - 5° set	OK - 4° set	Fracture	Fracture	Fracture
	OK - 6° set	OK - 5° set	Fracture	Fracture	Fracture
47	OK - 5° set	OK - 5° set	OK - 8° set	Fracture	Fracture
	OK - 8° set	OK - 6° set	Fracture	Fracture	Fracture
48	OK - 4° set	OK - 4° set	OK - 5° set	Fracture	Fracture
	OK - 7° set	OK - 7° set	Fracture	Fracture	Fracture

(*Please turn to page* 813)

Coulter & McKenzie **DRAW**·*PAK Equipment*



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Patents Pending

Continental Can Company Licensee

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THE COULTER & McKENZIE MACHINE CO., INC.

Hycar 2202—General Properties And Electrical Characteristics

by
Howard G. Womack, Development Engineer
B. F. Goodrich Chemical Company
Cleveland, Ohio
and
Gerard W. Kuckro, Advance Development Engineer
The General Electric Company
Bridgeport, Conn.

This paper was presented by Mr. Kuckro at the Regional Meeting of The Wire Association in New York City on April 28, 1955.

Mr. Womack graduated in 1948 from the University of Rochester, Rochester, N. Y., with a B.S. in Chemical Engineering. He joined the B. F. Goodrich Company in April, 1948, and has worked in the Raw Materials Inspection and Development Department, the Processing Division of the company in Akron, and has been with the Chemical Division since June, 1954, in his present position in the Hycar dry rubber group.

Mr. Kuckro graduated from St. John's University in 1931 with a degree of B.S. in Chemistry and then studied in the graduate school of Columbia University. He has been associated with the rubber industry for 20 years—8 years in the latex field and 12 years in the wire and cable field. He is now in G.E.'s Wire and Cable Department, Construction Materials Division, at Bridgeport

Introduction

Hycar 2202 is the trade name of a commercially available, bromine modified butyl rubber manufactured by the **B. F. Goodrich Chemical Company.** This polymer provides a new concept in the butyl field by virtue of its unique chemical and physical properties. The role of butyl in the wire and cable industry is widely known; additionally, the limitations of butyl in this field are equally known. Even the most unsaturated homologues in the butyl line still present curing problems in that highly accelerated, sometimes scorchy compounds are required in order to permit processing in commercially practical equipment. In addition to the slow cure rate, the aversion that butyl has for other polymers demands meticulous and expensive processing and handling methods to reduce the hazards of contamination. It is suggested that Hycar 2202 may solve many of the current problems found with butyl and fill a need in certain applications wherein all of the desirable properties of butyl are required without the problems encountered due to butyl's low unsaturation and cure rate.

Howard G. Womack

General Characteristics
Cure Mechanism and Cure Rate

Hycar 2202 is a modified butyl polymer containing bromine. Bromination occurs partly by addition and partly by substitution on the molecular chain. Vulcanization is accomplished by a dual system. A small amount of unsaturation remains and it is by this means that part of the cure can be accomplished with sulfur. At the same time vulcanization occurs through a reaction involving heavy metal oxides and the bromine present in the Hycar 2202[1]. This double curing system accounts for several unique properties described in the following paragraphs.

★ ★ ★

One of the most important manifestations of Hycar 2202 is that at equal acceleration levels its time to reach optimum cure is two to three times faster than GRI-17. This is illustrated by the Mooney Scorch Curves depicted on Plate I.

★ ★ ★

It can be seen that a 25% replacement of GRI-17 by Hycar 2202 cuts the cure time in half. A 75% replacement appears to provide optimum improvement.

★ ★ ★

(1) Butyl Type Polymers containing Bromine, R. T. Morrissey, B. F. Goodrich Research Center, paper delivered at the fall meeting of the Rubber Division, American Chemical Society, New York, September 15-17, 1954.

Gerard W. Kuckro

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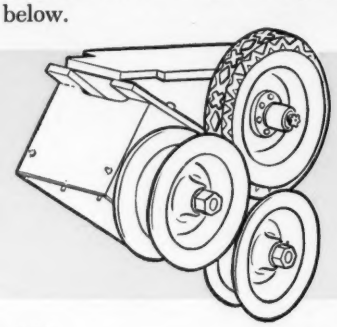
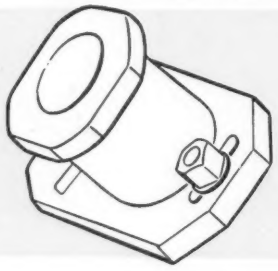


TRACTION UNIT . . . . . .

For maintaining tension on the free end of wire passing through a capstan. Normally mounted on capstan housing. One percent difference between speeds of capstan and traction unit produces slight slipping of wire on cast iron wheels and holds wire taut.

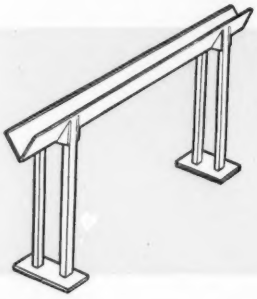


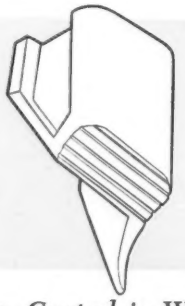
. . . . . AIR WIPER

For drying insulated wire after the cooling water cure. Air jets in the wiper blow the surface of the insulation dry. Can be mounted on the capstan housing. Often used to dry wire before it enters a diameter control.

COOLING TROUGHS . . . . . .

For cooling and setting thermoplastic insulation. Wire runs through flowing water inside V-shaped trough. First 5-foot section is retractable, additional sections are available in multiples of 15 feet.





. . . . . FEEDER BLOCK*

For smooth feeding of rubber compounds to extruder screw. Inserted into extruder feed throat, this cast iron block is so formed and machined that the screw itself continuously pulls compound, at the proper rate, into the extruder.

*Patents Applied for

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PLATE I

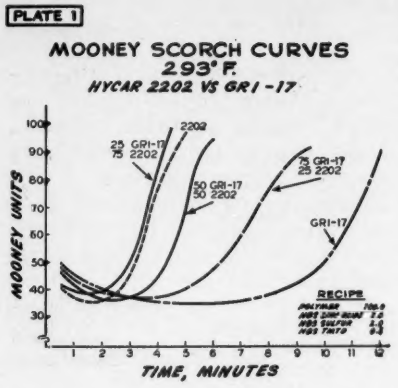


PLATE II

RECIPE		DATA						
Hycar 2202	100	Min. Cure @ 280°F.	15	30				
EPC Black[a]	50	Min. Cure @ 310°F.			5	10	25	50	100
NBS Zinc Oxide	5	Tensile	2100	2200	2150	2150	2160	2175	2200
NBS Stearic Acid	3	Elongation	680	650	680	700	660	650	640
NBS Sulfur	2	300% Modulus	800	875	775	775	875	900	960
NBS Bensothiazyl Disulfide	1	Shore "A" Hardness	73	74	72	73	73	75	74
NBS TMTD	2								
	163.0								

Hycar 2202 appears to have a flat stable cure with practically no reversion at excess cures. Plate II shows a recipe which is considered over-accelerated. When cured at 280°F., optimum properties are reached between 15 and 30 minutes. With this same recipe cured at 310°F. optimum properties are reached at 10 minutes and held essentially unchanged up to 100 minutes of cure. The physical properties were essentially equal for both curing temperatures.

★ ★ ★

Generally speaking, Hycar 2202 vulcanizates, depending on the type and volume of loading, develop lower tensile strength and elongation and higher modulus than comparable GRI-17 vulcanizates. As a result of a high state of cure lower compression set can be found in the Hycar 2202 vulcanizates.

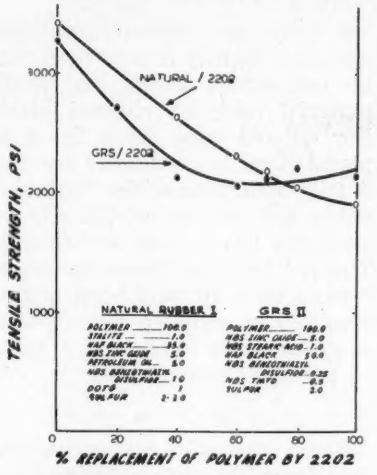
Blends With Natural Rubber and GRS

Another unique feature of Hycar 2202 which promises to permit wide application is its compatibility with a variety of other elastomers. Plate III shows the effect on tensile strength of stepwise replacement of both natural rubber and GRS in a test recipe. Additionally, Hycar 2202 has been found to be compatible with neoprene and Hypalon.

★ ★ ★

Coupled with this cure compatibility is the vast improvement in ozone resistance imparted by blending Hycar 2202 with GRS or natural rubber. For the same compounds shown on Plate III, Plate IV shows the stepwise improvement in ozone resistance of the covulcanizates as the percent of Hycar 2202 increases. For the natural rubber specimens, testing

PLATE III

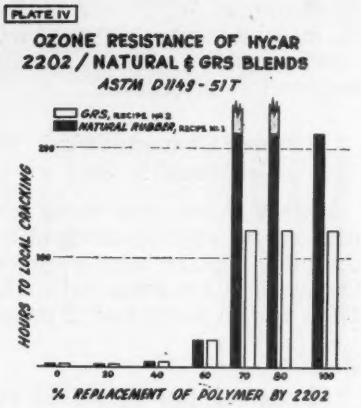


was stopped after 214 hours exposure. At the end of the period a few local cracks appeared in the 100% Hycar 2202 compound while no cracks appeared in the 70/30 or 80/20 blends. This follows along with some recent unpublished data which indicates improved heat aging when a small amount of natural rubber is present in the Hycar 2202 vulcanizate.

Adhesion Characteristics

Following along the same line

PLATE IV


OZONE RESISTANCE OF HYCAR 2202/NATURAL & GRS BLENDS
ASTM D1149-51T
GRS, RECIPE NO. 2
NATURAL RUBBER, RECIPE NO. 1
HOURS TO LOCAL CRACKING
% REPLACEMENT OF POLYMER BY 2202

as cure compatibility is the fact that Hycar 2202 offers a relatively simple means to adhere butyl to natural rubber and GRS as well as to steel, brass and aluminum. The adhesion of butyl to other vulcanizates was obtained by cementing the surfaces of the uncured compounds together with a Hycar 2202 cement and then press curing the sandwich. The most successful cement found to date is prepared by mill mixing 40 parts of an EPC black in 100 parts of Hycar 2202 and making up a 10% cement in n-heptane. High speed agitation is recommended as a final mixing cycle. Adhesion values up to 30 lbs./in. for butyl to GRS and over 55 lbs./in. for natural rubber have been obtained. The adhesion of butyl to GRS is difficult and the most successful results were obtained by using a thin Hycar 2202 compound as a tie gum. The adhesion values represent the load required to pull apart one by six inch test specimens in a shear at roughly 90 degrees to the plane of the bond.

★ ★ ★

Adhesion of butyl to brass, steel or aluminum is obtained in the following manner: the metal surface is first sandblasted and thoroughly degreased. A thin film of resorcinol-formaldehyde resin is applied to the surface and allowed to cure at 60° C. for 30 minutes. A thin film of Hycar 2202 cement is applied to both the butyl and resin surfaces. These pieces are heated 15 minutes at 60° C. to allow all solvent to evaporate. The two sections are pressed firmly together and cured conventionally. Adhesion values of greater than

75 lbs./in. at 76° F. and 60 lbs./in. at 250° F. were obtained on 1 inch wide strips of brass, alumium and steel so prepared.

Aging Characteristics Compared to GR-I

Plate V shows some aging comparisons between Hycar 2202 and the more popular butyl polymers. Comparisons are made with GRI-17 in carbon black loaded recipes and with GRI-35 in a clay/talc loaded recipe. The recipes are tabulated in Table I.

PLATE V

COMPARISON OF AGING CHARACTERISTICS OF HYCAR 2202 WITH GRI

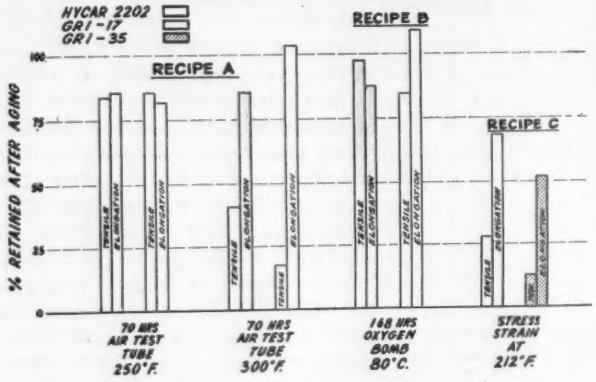


TABLE I

Recipe A		
Hycar 2202	100	-
GRI-17	-	100
NBS Zinc Oxide	5	5
SRC Black[a]	50	50
NBS Sulfur	2	2
NBS TMTD	.5	1
NBS Bensothiazyl Disulfide	.25	.5
	157.75	158.5

Recipe B		
Hycar 2202	100	-
GRI-17	-	100
Hydrated Lime[c]	5	-
NBS Zinc Oxide	-	5
Calcium Silicate[d]	10	10
Petrolatum	3	3
HAF Black[e]	50	50
Sulfur[f]	2	2
2-Mercaptobenzothiazole[g]	.75	1
D.O.T.G.[h]	.5	.75
	171.25	171.75

Recipe C		
Hycar 2202	100	-
GRI-35	-	100
Process Oil[j]	5	5
NBS Stearic Acid	1	1
Paraffin	2	2
NBS Zinc Oxide	5	5
Hard Clay[k]	75	75
Talc[l]	75	75
TMTD[m]	1	1
Sulfur[n]	3	3
2-Mercaptobenzothiazole[g]	.5	.65
Tellurium Diethyl Dithiocarbamate[o]	1	1.3
	268.5	268.95

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In all cases Hycar 2202 shows a greater retention of tensile strength. In the cases of the air test tube and oxygen bomb aging, the GRI-17 has indicated by high elongation and lower tensile values that reversion has commenced whereas no reversion is evident in the Hycar 2202 compounds. This excellent aging characteristic is present in spite of a generally faster and tighter cure as discussed previously.

Compounding and Mixing

Hycar 2202 is compounded generally in the same manner as butyl, the exception being that reduced acceleration levels are recommended. The amount of reduction tolerable depends on the type of system used. Generally speaking, both primary and secondary acceleration requirements are lower to the extent of being as little as one-half the recommended level for standard butyl in alkaline compounds and only slightly higher than that in compounds containing acidic material such as channel black. For quinoid type cures the compounds tend to be slightly scorchy. A 25% reduction of the "quinone" phase and the use of the dibenzo variation has proved satisfactory. The red lead requirements should remain at a 10 part level and in specific compounding where resistance to water is necessary, up to 15 parts is recommended.

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Some successful curing systems found per 100 parts polymer are:

Sulfur 2.0; benzothiazyl disulfide 1.0; DOTG 0.1

Sulfur 2.0; benzothiazyl disulfide 0.25; TMTD 0.5

Sulfur 1.5; p.p' dibenzoyl quinone dioxime 4.0; red lead 7.0

Sulfur 2.0; p.quinone dioxime 1.0; benzothiazyl disulfide 1.0; 2-Mercaptobenzothiazole 0.25

★ ★ ★

To compound for maximum resistance to mechanical water absorption, the quinoid type cure has been found to be most successful. The presence of zinc oxide increases the water sensitivity. Replacement of 5.0 parts of zinc oxide with 10.0 parts litharge achieves essentially the same state of cure with improved water resistance.

★ ★ ★

Certain unsaturated reinforcing resins are incompatible with butyl. It has been found that high-styrene/butadiene resins are compatible with Hycar 2202 and do provide a degree of reinforcement. This area of reinforcing resins has not been fully explored at the present, but does suggest the possibility of the use of many materials with promising properties.

★ ★ ★

The mixing of Hycar 2202 is accomplished in the same manner as standard butyl. Hycar 2202 accepts pigments readily and uses the same mixing cycle as butyl. Hycar 2202 compounds tend to be more scorchy than standard butyl compounds, thus in Banbury mixing it is necessary to add the curing ingredients on the sheet off mill to permit maximum safety. Dibenzo GMF and red lead tend to be scorchy when added as free pigments, thus it is recommended that

these accelerators be added as a master batch.

Electrical Characteristics

Having seen the general characteristics of Hycar 2202, we shall take a specific example, namely when Hycar 2202 is compounded primarily for use as a solid dielectric and compare the values thus obtained with the best electrical grade of butyl.

Electrical Grade Compounds — PLATE VI

	D	E	F
GRI-35	100	-	-
Hycar 2202	-	100	100
Whitetex #2(p)	102	102	113
EPC Black(b)	10	10	10
Stearic Acid(q)	2	2	2
Zn O(r)	5	5	-
Pb_3O_4(s)	10	10	-
	229	229	225
Sulfur(t)	1	1	1
Dibenzo GMF(u)	6	6	-
PbO Subl.(v)	-	-	10
	236	236	236

PLATE VIII

Aver. of 3 Samples	Power Factor and S.I.C. Dry @ 25° C. PF 60~1000 V	SIC 60~1000 V	PF 1000~10 V	SIC 1000~10 V	Insulation Resistance Dry@25°C. 500V D.C. 10^{12} Ohms/cm³	Power Factor and S.I.C. 16 Hrs. in Water @25°C. PF 60~1000 V	SIC 60~1000 V	PF 1000~10V	SIC 1000~10V	Insulation Resistance 16Hrs.H₂O 500V D.C. 10^{12} Ohms/cm³
Butyl Rubber (Stock D)	.01131	3.72	.0141	3.61	ALL*	.01396	3.73	.0144	3.63	ALL*
Hycar 2202 (Stock E)	.01134	3.66	.0135	3.56	SAMPLES AT	.01203	3.69	.0135	3.56	SAMPLES AT
Hycar 2202 (Stock F)	.00814	3.58	.0107	3.48	INFINITY	.0107	3.63	.0128	3.53	INFINITY

* Based on average thickness of .0146 = 8220. 10^{12} Ohms/cm³

Dielectric Strength (Voltage Breakdown)

	Dry @ 25° C. Thick	ACKV	Volts/Mil.	After 16 Hrs. in Water @ 25° C. Thick	ACKV	Volts/Mil.
Butyl Rubber (Stock D)	.0346	25.9	749.	.0323	26.0	809.
Hycar 2202 (Stock E)	.0447	30.	671.	.0438	30.	686.
Hycar 2202 (Stock F)	.0638	38.5	603.	.0612	37.9	620.

case has progressed to a very high degree as evidenced by the physical tests and Mooney Scorch values. It is noteworthy, however, that this inorganic accelerator system results in an extremely short induction period, — without the necessity of relatively expensive organic curatives. Compound modification should permit retention of the very low power factor while possible a faster rate of cure, compatibility with a variety of other elastomers, and excellent adhesion characteristics to other elastomers as well as ferrous and non-ferrous metals. In addition to these improvements, it retains the excellent properties of butyl such as low temperature flexibility, ozone and sunlight resistance, good flex life, low air diffusion and excellent aging characteristics. Lastly, it furnishes to the electrical insulation industry a solid dielectric which is superior in many respects to the best electrical grade of butyl.

PLATE VII

Stock No.	UNAGED Tensile # PSI	Elong. %	Mod.(200%) # PSI	AGED 20 Hrs. Air Bomb %Tensile Retent'n	% Elong. Reten'n	48 Hrs. @ 150° C %Tensile Retent'n	% Elong. Reten'n
D	895	550	450	73	81	56	60
E	695	320	595	100	80	86.5	56
F	920	490	490	76.5	99	34.0	64.5

MLR/250° F. (1½' Conditioning)

	D	E	F
Min. Mooney	27	37½	53
1 pt. over Low (minutes)	14	7½	4
2 pts. " " "	16½	9	4½
3 pts. " " "	19½	9½	5
4 pts. " " "	21½	10½	5½
5 pts. " " "	23½	11	5-3/4

Low Temperature Flexibility (Goodrich Guillotine Test)

Compound No. D	-44° C.
" " E	-38° C.
" " F	-42° C.

Ozone Resistance (0.030% ozone @ 25° C.)

	D	E	F	
180° Bend -	O.K.	O.K.	Ruptured	24 Hrs.
25% Elongation -	O.K.	O.K.	" "	24 Hrs.
	Ruptured	Ruptured	" "	96 Hrs.

Recipe F is of interest since it demonstrates the possibility of producing Hycar 2202 vulcanizates without the need of any organic accelerators. By virtue of the excessive quantities of litharge and sulfur, the cross-linking in this improving the ozone resistance and Mooney Scorch characteristics.

Summary

Hycar 2202, in satisfying a need in the butyl rubber field, makes

Acknowledgment

The authors wish to acknowledge the helpful assistance of R. T. Morrissey of the B. F. Goodrich Company, and W. S. Farrell of General Electric Company.

LIST OF SUPPLIERS

	Trade Name	Supplier
(a) EPC Black	Wyex	J. M. Huber Co.
(b) EPC Black	Spheron 9	Godfrey L. Cabot, Inc.
(c) Hydrated Lime	C_aOH	Fisher Scientific Co.
(d) Calcium Silicate	Silene EF	Columbia-Southern Chem. Corp.
(e) HAF Black	Philblack O	Phillips Petroleum Co.
(f) Sulfur	Blackbird Brand	Mathieson Chemical Corp.
(g) 2-Mercapto-benzothiazole	Captax	R. T. Vanderbilt Co.
(h) Di orthotolyl Guanidine	DOTG	Calco Chemical Div.
(j) Process Oil	Circosol 2XH	Sun Oil Co.
(k) Hard Clay	Burgess 30	Burgess Pigment Co.
(l) Talc	#21 Talc	Eastern Magnesia Talc Co.
(m) TMTD	Methyl Tuads	R. T. Vanderbilt Co.
(n) Sulfur	Spider Brand	Mathieson Chem. Corp.
(o) Tellurium Diethyl Di Thiocarbamate	Tellurac	R. T. Vanderbilt Co.
(p) Calcined Clay	Whitetex #2	Southern Clays, Inc.
(q) Stearic Acid	Stearex	Binney & Smith Co.
(r) Zinc Oxide	XX78	New Jersey Zinc Sales Co.
(s) Pb_3O_4	Red Lead	Eagle-Picher Sales Co.
(t) Sulfur	Tire Grade	Stauffer Chemical Co
(u) p.p'dibenzoyl-quinone dioxime	Di Benzo GMF	Naugatuck Chemical Co.
(v) PbO	Sublimed Litharge	National Lead Co.

"Kel-F" Plastic for the Wire and Cable Industry

by Jules A. Jupa, Sales Engineer
M. W. Kellogg Company
Jersey City, New Jersey

Mr. Jupa delivered this paper at the New York Regional Meeting of The Wire Association on April 28, 1955.

In 1947, The M. W. Kellogg Company announced the commercial production of a series of new high temperature thermoplastics. These new materials were identified chemically as polytrifluorochloroethylene and were sold under the name of "KEL-F" plastic, a trademark of the M. W. Kellogg Company for its fluorocarbon polymers.

★ ★ ★

The plastic polymer of trifluorochloroethylene was the result of extensive work by Dr. William T. Miller and co-workers. The M. W. Kellogg Company of Jersey City, New Jersey, became acquainted with this material and its superior corrosion and thermal qualities. During the first few years after its discovery, its primary use was for military purposes.

★ ★ ★

It was soon discovered that "KEL-F" plastic, being a true thermoplastic, was adaptable to the use of standard injection, extrusion, transfer and compression molding equipment with minor modifications. This new material broadened the field of thermoplastic materials from -330° F. to +392° F. and offered solutions to many problems that were not possible with existing materials. "KEL-F" plastic has in its short lifetime been successfully employed in an ever increasing number of severe applications in the electronic, chemical and equipment fields.

Chemical and Physical Properties

The polymer is a solid, homogeneous material which may be characterized by the general formula CF_2CFCI (x times). The halogens, fluorine and chlorine, are present in the compound in a ratio of 3 to 1. The fluorine contributes to its great thermal stability and excellent electrical properties. The chlorine offers transparency and true thermoplastic flow.

★ ★ ★

Since "KEL-F" plastic is a completely halogenated polymer, it has, as may be expected, excellent resistance to burning, that is, it does not support combustion after a flame has been applied and removed from its surface.

★ ★ ★

The chemical resistance of "KEL-F" plastic is outstanding to most corrosive agents. Red and white fuming nitric acid, hydrogen fluoride, peroxides, concentrated and dilute sulfuric, hydrochloric and acetic acids, alkalies and organic solvents do not attack "KEL-F" plastic. Certain halogenated hydrocarbons have a tendency to slightly swell "KEL-F" plastic but do not necessarily preclude the use of this material in contact with them, since the degree of absorption is relatively small and general dimensions are retained for the most part.

★ ★ ★

There are only two materials of approximately 45 thermoplastic and thermosetting materials listed in the Modern Plastic Encyclopedia which claim to have 0.00% moisture absorption. "KEL-F" plastic is one of these materials. The combination of zero moisture absorption, low permeability and non-wetting characteristics make this polymer very desirable for electrical applications.

★ ★ ★

Thin sections, from .030" to approximately .060" thick, can be flexed through 360° at a temperature of -320 to -330°F., without cracking. Furthermore, "KEL-F" plastic can be taken from elevated temperatures in the neighborhood of 400° and higher, and quickly subjected to the low temperatures of liquid nitrogen. This resistance to thermal shock is shared by very few materials.

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Arc resistance is greater than 360 seconds and failure occurs from melting of the test electrodes through the "KEL-F" plastic sheet and not carbonization between electrodes, either on or through the plastic mass.

★ ★ ★

Specific abrasion resistance tests rate polyvinyl 10^3; nylon at a rating of 10^{11}; and "KEL-F" plastic with a rating of 10^8. These numbers are relative indications of abrasion resistance and also the number of scrapes to failure. These data indicate that "KEL-F" plastic approaches nylon in abrasion resistance.

★ ★ ★

In thin sections, "KEL-F" plastic can be made transparent to visible and invisible light. Transmission of infrared light between 6 microns and 2 microns is between 75 and 95%.

★ ★ ★

The volume resistivity of "KEL-F" plastic from room temperature is 1.2×10^{18} and at temperatures in the neighborhood of 200°C. is 3.0×10^{14} ohms/cm. The retention of high volume resistivity over a broad temperature range is a unique characteristic because many other materials record a sharp decrease in volume resistivity as the temperature is raised above room temperature. Insulation resistance was found to be greater than 1300 megohms per thousand feet when measured at 500 volts DC.

The presence of chlorine in the molecule creates a dipole moment which shows variation of power factor and dielectric constant over normal operating range at room temperature. For general frequencies, the dielectric constant and power factor are excellent. The dielectric constant varies from 2.7 at 100 cycles to approximately 2.3 at 10^9 cycles. The dissipation factor varies from .015 at 60 cycles to .003 at 10^9 cycles.

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The dielectric strength of "KEL-F" plastic in a 1/8" sample is 530 volts/mil. In a sample approximately 5 mils thick, it is 2,500 volts/mil. Tensile strength of "KEL-F" plastic in the unorientated form is between 5,000 and 6,000 psi. As the degree of orientation increases, tensile strengths as high as 30,000 to 50,000 psi have been obtained. This high tensile strength coupled with low deformation under load and resistance to cold flow offers desirable mechanical advantages to electrical equipment.

Amorphous and Crystalline Properties

The useful life of most high polymers is, to a great extent, dependent on their residual molecular weight, that is the higher the molecular weight generally, the greater toughness, resistance to heat, flexural strength, elongation, etc. Many high polymers are thermally degraded or experience a drop in molecular weight when exposed to certain high temperatures. "KEL-F" plastic can be exposed to 250°C (480°F.) for several hours without suffering thermal degradation. However, at approximately 265°C. (508°F.), material breakdown is initiated slowly. As the temperature is raised in the direction of 300°C. (572°F.) or higher, the rate at which breakdown occurs increases quite rapidly. In the neighborhood of 300-310°C. (572-590°F.), serious breakdown can occur within a few minutes. It is therefore possible to visualize products made from a thermoplastic material which may be exposed to a broad operating range, to exhibit various degrees of thermal degradation or decrease the molecular weight from the original molecular weight to a rather low value.

★ ★ ★

Generally, as the molecular weight decreases, the mobility of the molecules and tendency to form more crystalline areas is increased. When exposed to high temperatures for extended periods of time, roughly from 150°C. (302°F.) and higher, the degree of crystallinity increases and the polymer becomes harder and more brittle. In an effort to form a more crystalline structure in a lower molecular weight region, these products may have a tendency to crack and become useless. It has been noted that as the molecular weight increases, although crystallinity may occur and the product increases in hardness and stiffness, a good measure of the toughness of the amorphous product is retained.

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Recent work has shown that "KEL-F" plastic polymers can exist in macro and micro crystalline form or a mixture of both types. The macro crystals can be observed under cross polaroids; the micro crystals are sensitive to X-ray examination. To a great extent, the final crystalline form is dependent on its thermal history and the nature of the cooling mechanism. By rapidly cooling the polymer through its transition point of approximately 211°C. (411°F.) to a point below 150°C. (302°F.), an essentially amorphous condition is obtained. However, if the polymer is slowly cooled from a point above its transition point to a point below 150°C. (302°F.), a more crystalline condition is obtained. In all cases, crystallites can be found to a greater or lesser degree, that is, the polymer is never completely amorphous or never completely crystalline.

★ ★ ★

Crystal growth can be induced by exposing an essentially amorphous sample to temperatures above 150°C. (302°F.). This means that a material that has been badly degraded during the molding operation, can develop a high degree of crystallinity and embrittlement when exposed above these temperatures, whereas, a material that has not been degraded during the molding process will develop a lesser degree of crystallinity and retain its essential toughness.

★ ★ ★

The work done in the wire coating field has indicated that a high degree of strain (60-75%) will inhibit macro crystalline growth in samples which have been thermally degraded. Usually, maximum crystallinity is developed within 24-48 hrs. after aging at 150°C. (302°F.). Experimental work indicates that no significant crystallinity develops after 1 week aging at 150°C. (302°F.).

"Kel-F" Plastic Molding Materials

"KEL-F" plastic is sold in the form of high density molding powder or granules and as a low density molding powder or a free-flowing powder. The granules have a compression ratio of roughly 2 to 1 and the low density powder has a compression ratio of roughly 6 to 1. The high and low density powders in the unplasticized form are designated by grade numbers, namely, 270 and 300. The 270 grade material has a molecular weight roughly of 75,000. The 300 grade material has a molecular weight of roughly 110,000 units. The 270 and 300 grade materials can be plasticized with lower molecular weight "KEL-F" polymer oils to give more flexible products. For general purpose application, Grade 300 P-25 is recommended for applications requiring plasticized material. It is possible, however, to vary the amount of plasticizer which may be added to the high polymers to obtain different degrees of flexibility between that of maximum plasticizer compatibility and the unplasticized resin.

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For the most part, "KEL-F" plastic Grade 270 and 300 are used for wire and coating work. These materials, of course, have the advantages of an unplasticized material and also some of the disadvantages, such as greater rigidity. Unless otherwise indicated, the discussion here will deal with the unplasticized materials in either grade 270 or 300 form. There is no significant physical difference

between Grade 270 and 300. However, for extended high temperature use, the high molecular weight material, namely, Grade 300, is usually recommended. This does not necessarily mean that if Grade 300 material is used, the resultant product will have a high molecular weight. However, if the appropriate temperature considerations are observed, it is possible for the resultant product to retain its high molecular weight and be more serviceable at elevated temperatures.

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The M. W. Kellogg Company supplies to the wire industry clear and white colored molding powder. This white pigmented material is primarily intended as a background for the "KEL-F" striping inks.

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The striping inks are furnished in 10 different and distinct colors, and can be applied on the conventional Entwistle machine. The development of striping inks for "KEL-F" plastic has increased the coding possibilities considerably. These same striping inks can be exposed to elevated temperatures. They do not, however, have the outstanding chemical resistance that the basic polymer possesses and must be used with the necessary care and understanding. Certain aromatic hydrocarbons and ketones will have a tendency to smear the inks if the coated wire is immersed in them for an extended period of time. However, where these reagents may be present, solid colors can be used without ill effect. For many applications, high temperature resistance and distinct color markings which possess good adhesion will serve many useful purposes. The M. W. Kellogg Company is actively engaged in research and development in these fields. A recent interesting development on the use of "KEL-F" inks has been reported where these inks have shown superior properties for striping nylon covered wire.

Signal Corps Evaluation

The failure of standard polyvinyl chloride insulated wire to meet temperature requirements of 110-120°C. in various Signal Corps' equipment initiated the first work on polytrifluorochloroethylene as a potential wire coating material. The reason for the failure of vinyl wire was due to short circuits caused by condensation of volatile plasticizers on the connectors located in the coldest portion of the equipment. The development of "KEL-F" insulated hook-up wire was stepped up rapidly by the active interest and encouragement of the Signal Corps Engineering Laboratories. It was under the guidance of Messrs. Tenser and Spergel that test evaluations were made, which resulted in the present MILW-12349 Specification for polytrifluorochloroethylene hook-up wire. The aforementioned specification rates this hook-up wire as satisfactory for the following conditions and temperature ranges:

1. Short time (4 hrs.) —55° C. (—67° F.) to +190° C. (374°F.) maximum hot spot.
2. Intermittent (250 hrs.) —40° C. (—40° F.) to +150° C. (302° F.) maximum hot spot.
3. Continuous —40° C. (—40° F) to +135° C. (275° F.) maximum hot spot.

★ ★ ★

The Signal Corps Laboratory also recommended further investigation to develop and improve the performance of polytrifluorochloroethylene coated wire for continuous use at a maximum hot spot temperature of 175°C. (347°F.). This development work is now being conducted by the Revere Corporation of Wallingford, Connecticut.

Extrusion

Electrically heated 1-1/2", 2-1/2" and 3-1/2" extruders have been used for "KEL-F" wire coating work. For the most part 1-1/2" and 2-1/2" machines have been used. Electrically heated units are generally preferred because of the higher temperatures required along the length of the barrel and in the dies themselves.

★ ★ ★

The materials of construction for the dies and the screws must be considered seriously. Stainless steels, namely, 303 or other high grade stainless steels, chromium plated steels, X-alloy 306 and duranickel have been found satisfactory for the barrel, screw and dies.

★ ★ ★

Conventional full-flighted screws with a uniform pitch and having compression ratios between 150 and 250% have proved satisfactory. It is important that shallow depths between the flights be considered. In larger machines, such as the 2-1/2 and 3-1/2" machine, a metering type of screw appears to give better conversion. Usually, relatively low screw speeds are used for "KEL-F" plastic wire coating work. Screw speeds of 3 to 12 rpm may be necessary.

★ ★ ★

For the most part, the tube-on technique is used in "KEL-F" wire coating work. This means that the crosshead is mounted in a vertical manner. After the plastic mass is drawn onto the wire, it is immediately quenched in water, which may be held in a tank resting on the floor of the shop. Usually, all of the necessary cooling has been accomplished within this tank and the wire may be then passed through the system in the conventional manner. Using the tube-on technique, the die sizes are generally much larger than those encountered in straight pressure type extrusion, e.g., the die required to coat a 22-gauge 7/30 wire would have a die bushing I.D. of approximately 1/2 (0.500") and a mandrel or guider O.D. of 0.300". The land of the die would be approximately 1-1/2" to 2". The plastic mass, having roughly an O.D. of 1/2" with a 0.100" wall is drawn down on the wire, giving an overall O.D. of 0.050" with a 10 mil wall, roughly. a 10 to 1 drawdown ratio, at wire speeds in the neighborhood of 150 to 250 ft. per minute.

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It is most important that a very constant and uniform heat be maintained throughout the entire system. For general production requirements, the off and on controls are not considered desirable. The proportionating type of instruments or more preferably the stepless type of control is suitable.

The temperatures from the extended die bushing to the hopper zone may be roughly as follows: Extended die bushing, 630°F.; die head, 575-600°F.; front heater, 550-575°F.; rear heater, 400-450°F. The hopper zone is kept cool by circulating a small amount of cold water through the cooling chambers.

"Kel-F" Wire Constructions

It appears that the **Surprenant Company** of Clinton, Massachusetts, was first to make a suitable wire for Signal Corps requirements. Shortly thereafter, the **Revere Corporation** of Wallingford, Connecticut, moved into production. They were followed by the **Rex Corporation** of West Acton, Massachusetts, then the **William Brand Company,** and finally the **Federal Telephone and Radio Corporation** of Clifton, New Jersey, entered the field to produce "KEL-F" coated wire and cable for external and internal use. As the foregoing companies became more familiar with the problems connected with "KEL-F" wire coating, more varied and complex constructions were developed.

★ ★ ★

The Surprenant Company has produced 600 volt hook-up wire from AWG 30 to AWG 8. Miniature coaxial cable — 50, 70, 93 ohm impedance values. Jacketed multiconductor and multi-twisted pair with plasticized and unplasticized jackets. The Revere Company has continued to produce hook-up wire and other types of wire for regular industrial use, as follows:

1. **Single conductor, 10-28 gauge silver plated copper hook-up wire.**
2. **Two and three twisted, not jacketed, cable.**
3. **Six conductor cable with plasticized and unplasticized jackets.**

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The Rex Corporation is producing, at the present time, the following types of "KEL-F" plastic covered wire construction:

1. **Silver plated copper conductor with a 16-gauge wire 19/29, with a shield of #36 copper braid.**
2. **Two conductor cable shielded and jacketed with "KEL-F". Conductors are 20-gauge 7/28 silver plated copper twisted into a pair, using a #36 silver plated copper shield. The jacket consists of a 0.20" "KEL-F" wall.**
3. **Two conductor "KEL-F" cable shielded and jacketed. The two conductors are silver plated copper, 22-gauge wire 7/30 with a shield #36 tin copper and a jacket approximately .030" of black PVC.**
4. **Two conductor "KEL-F" cable. The two conductors are set parallel, using #16 silver plated copper wire 19/29 and a braided shield of #36 tin copper.**
5. **A 37 conductor cable made up of 37—22-gauge wires 7/30 silver plated copper, covered with a silicone glass braid.**

★ ★ ★

The Federal Telecommunication and Radio Corporation is producing the following types of wire construction:

1. **A single conductor, 22-gauge, 730 silver plated copper wire with a .010" "KEL-F" Wall.**
2. **A single conductor, #16/19/29 and silver plated wire with a 12 mil wall. They are also producing miniature coaxial cables of 3 types, namely, K-258, K-256 and K-257. These are comparable to the RG types, 62/U RG-8U and RG-11U respectively.**

★ ★ ★

The foregoing are some of the constructions being produced at the present time. It is difficult, however, for the resin manufacturer to know the exact conditions of use because the operating conditions may not be available to the wire coater.

★ ★ ★

There is a growing tendency to use "KEL-F" plastic coated wire in many commercial and industrial wiring applications which are varied and extremely complex, even though materials of a lower price may suit the overall purpose. The demand for quality materials will result in a minimum wire replacement over an extended period of time and thus reduce ultimate servicing costs.

Areas of Use

"KEL-F" plastic has a unique combination of properties which cover a relatively broad field of use. The following suggestions which may be considered to justify the use of "KEL-F" coated wire for more complex constructions are:

1. **Where high temperatures, 190° C. for short periods of time (4 hrs.) or for continuous use below 150° C.**
2. **Where superior corrosion resistance to corrosive acids and alkalies may be encountered.**
3. **Where moisture absorption, permeability or wetting are factors and where flexibility is not of prime importance.**
4. **Where abrasion resistance and ease of movement through conduits are important.**
5. **Where long term quality may be required at lower temperature.**
6. **Where thermal shock, fungus growth and storage occur.**
7. **Where small size and light weight make them substitutes for standard lines, where space is limited.**

"Kel-F" Plastic Versus Kel-F Elastomer

Recently, The M. W. Kellogg Company of Jersey City, New Jersey, announced the production of a fluorocarbon rubber identified by the trade name KEL-F Elastomer. This rubberlike material, like "KEL-F" plastic, is outstanding for its extreme chemical resistance. It is resistant to strong oxidizers, mineral acids, peroxides, alkalies, alcohols and aliphatic solvents, hydraulic fluids and solvents. The KEL-F Elastomer is recommended for continuous use at 400°F. The water absorption of the elastomer in milligrams per square inch at 77°F. is 3.5 after 65 days. For the same period of time, Neoprene absorbs 12.9 milligrams per square inch, grm. 13.5 mg/sq.in., polyethylene 5.1 mg/sq.in.

★ ★ ★

For certain applications, the "KEL-F" plastic coating is not sufficiently flexible and we suggest for your evaluation the KEL-F Elastomer. The electrical properties of "KEL-F" Plastic versus the KEL-F Elastomer are tabulated below:

COMPARISON OF ELECTRICAL PROPERTIES
OF "KEL-F" PLASTIC VERSUS KEL-F ELASTOMER

	"KEL-F"	KEL-F Elastomer
Dielectric Strength, volts/mil	530	613
Volume Resistivity, ohms/cm	1.2×10^{18}	1.1×10^{14}
Dielectric Constant, 60 cycles	2.6	6.27
Dielectric Constant, 10^6 cycles	2.3	3.9
Power Factor at 60 cycles	0.015	0.025
Power Factor at 10^6	0.008	0.113

The electrical properties of the elastomer generally are in the same category as most vinyl compounds.

(*Please turn to page* 814)

Wire Insulated with "Teflon"* Tetrafluoroethylene Resin For High Temperature Uses

by John J. Ondrejcin, Product Specialist
E. I. du Pont de Nemours & Co., Inc.
Wilmington, Delaware

"Teflon" has been established as a Class C material for electrical insulation with a continuous upper operating temperature of 250° C. Data are presented to show its dielectric properties before and after heat aging for six months at 250° C. Finally, a survey is presented of applications for wire insulated with "Teflon."

Dr. Ondrejcin presented this paper on April 28, 1955, before the New York Regional Meeting of The Wire Association in New York City.

"Teflon" tetrafluoroethylene resin is now a familiar material as a wire insulation. This is in contrast to its early years when "Teflon" was considered as a highly specialized material to be used only in place of the usual dielectrics in order to fulfill stringent end use requirements.

★ ★ ★

Let us look at the reasons why "Teflon" is becoming an increasingly important wire insulation (Figure 1).

FIRST:	"TEFLON" HAS EXCELLENT PHYSICAL, ELECTRICAL, AND CHEMICAL PROPERTIES.
SECOND:	"TEFLON" HAS BEEN ESTABLISHED AS A CLASS C DIELECTRIC.
THIRD:	WIRE INSULATION OF "TEFLON" CAN NOW BE COLOR CODED.
FOURTH:	NUMEROUS NEW IMPROVEMENTS IN FABRICATION TECHNIQUES FOR "TEFLON" HAVE BEEN DEVELOPED.
FIFTH:	WIRE INSULATED WIRE "TEFLON" IS ECONOMICALLY COMPETITIVE.

FIG. 1

Properties

In Figure 2 typical properties of "Teflon" important in wire insulation uses are shown for three of the common forms, namely: tape, hook-up wire insulation, and supported tape. In addition to the properties shown, insulation of "Teflon" will not be attacked by any ordinary chemicals except molten alkali metals and fluorine gas at elevated temperatures and pressures. This unusual combination of properties makes "Teflon" a good insulation in nearly all wire applications.

FIG. 2

PROPERTIES	TAPE OF "TEFLON"* (1)	HOOK-UP WIRE INSULATION OF "TEFLON"*	SUPPORTED TAPE OF "TEFLON"* (2)
DIELECTRIC STRENGTH V/MIL	900	1100	700
DISSIPATION FACTOR	0.0005	0.001	0.0007
DIELECTRIC CONSTANT	1.90	2.15	2.60
SURFACE RESISTIVITY MEGOHMS	$>10^5$	$>10^5$	$>10^5$
VOLUME RESISTIVITY OHM-CM	$>10^{18}$	$>10^{15}$	$>10^{12}$
ARC RESISTANCE, SECONDS	250	—	160
MOISTURE ABSORPTION %	0.07	—	0.03
TENSILE STRENGTH PSI	3000	—	22,000
ELONGATION %	250	—	—

* Registered Trade Mark of the Du Pont Co.
(1) Prepared from Molded Cylinder
(2) Supported on Glass Fabric

★ ★ ★

Thermal Classification

We mentioned earlier that "Teflon" has been established as a Class C dielectric. Most of you are familiar with the AIEE Standard No. 1 which includes organic materials in Class A, inorganic base materials combined with an organic impregnant in Class B, silicones in Class H, and in Class C, inorganic materials like glass, asbestos, and mica. Recently these definitions and classes have proved inadequate in that the newer dielectric materials do not fit both the chemical definition and the thermal classification. Secondly, the design of much electrical equipment specifies combinations of materials, yet the highest service temperature is needed only in one part of the design. Finally, it is now recognized that many applications require high service temperatures for only a short length of time—not 20 years as was previously the case. Thus, considerable effort has been directed in the last two or three years both here in the U. S. and abroad toward revising the thermal standards and toward incorporating the newer materials such as "Teflon." In Figure 3, we see the proposed new temperature standard. Included are examples of typical materials representing the various classes.

PROPOSED THERMAL CLASSIFICATION OF DIELECTRICS

CLASS	MAXIMUM SERVICE TEMPERATURE, °C.	REPRESENTATIVE MATERIAL
Y	90	POLYETHYLENE, COTTON
A	105	PHENOLICS, CELLULOSE ACETATE
E	120	"MYLAR"* POLYESTER FILM
B	130	"ZYTEL"* NYLON RESIN, "FORMVAR"
F	155	"KEL-F",* "ALKANEX"
H	180	SILICONE GLASS FABRIC, SILICONE RUBBER
C	>180	"TEFLON"* CERAMICS, GLASS

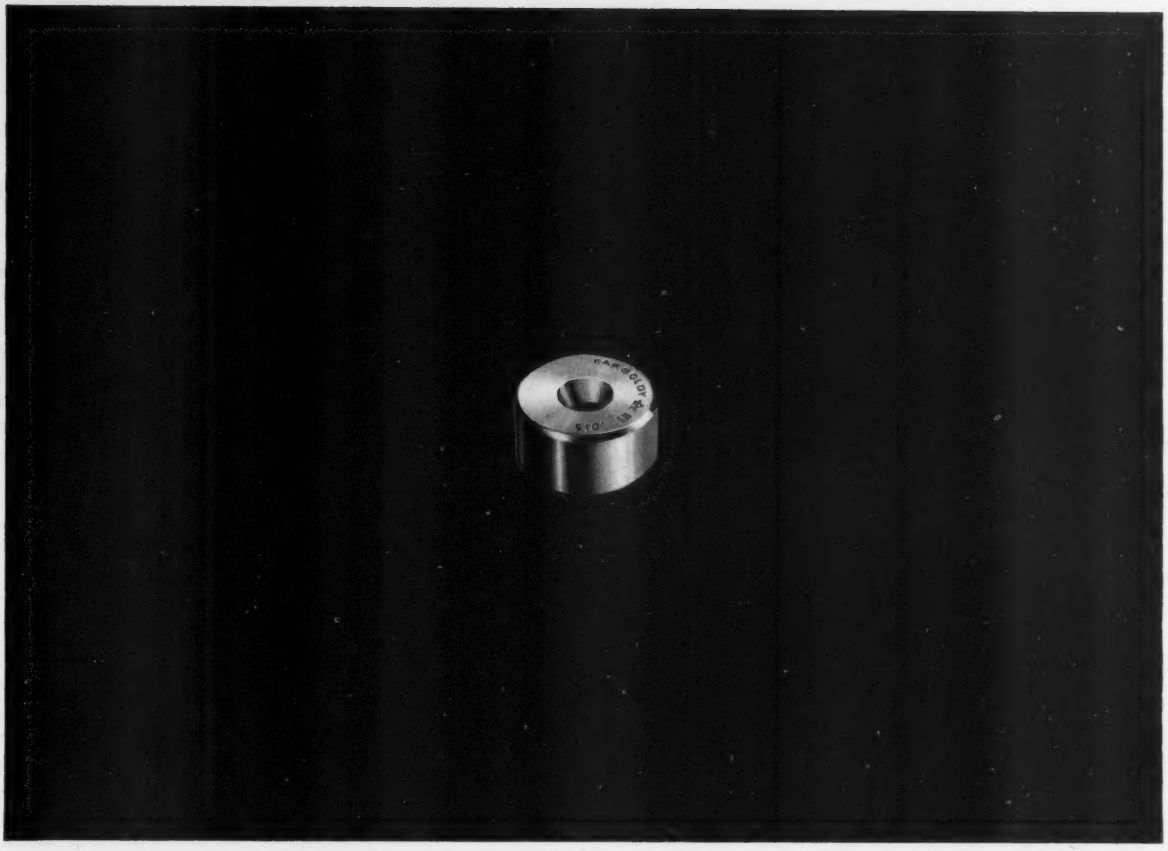
* Registered Trade Marks of the Du Pont Co.
FIG. 3

"Teflon" tetrafluoroethylene resin has been placed in Class C. For continuous use, a conservative upper operating temperature for "Teflon" is 250°C. Du Pont and other companies have obtained impressive data to show the effect of this temperature on "Teflon" used as a wire insulation. The next series of figures presents the effect of heat aging on the electrical properties of "Teflon." Three types of materials used for wire insulation were heat aged for 6 months at 250°C during which time the electrical properties were determined at intervals.

★ ★ ★

Figure 4 emphasizes how small a change takes places in the dis-

* Trade mark for Du Pont tetrafluoroethylene resin.



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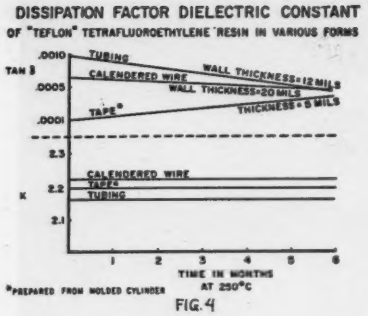

FIG. 4

sipation factor and dielectric constant of "Teflon" upon heat aging. As shown in Figure 5 no change in insulation resistance occurs.

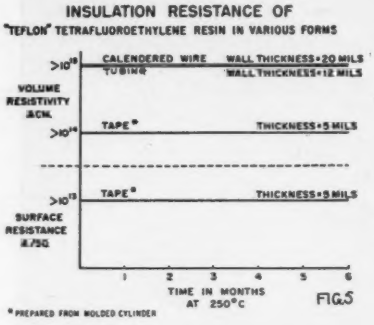

FIG. 5

Figure 6 is a plot of dielectric strength versus heat aging time which shows markedly the minimum dielectric breakdown which occurs. Notice too, the almost negligible decrease in the values. These data also show that the dielectric strength of samples of "Teflon" depends upon their thickness just as for all other dielectrics.

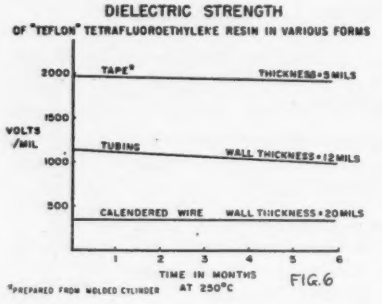

FIG. 6

Figure 7 of this series shows that prolonged heat aging time does not affect the arc resistance of "Teflon."

★ ★ ★

Summarizing this information, the data show clearly that there is essentially no change in the

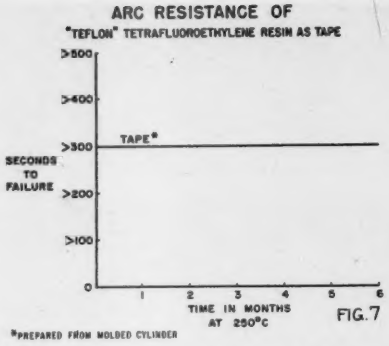

FIG. 7

dielectric properties of "Teflon" even after heat aging at 250°C for 6 months. This is in sharp contrast to experience with other organic materials used for wire insulation.

★ ★ ★

While the effects of heat aging upon the dielectric properties of an insulation are of prime importance to the design engineer, he also requires a knowledge of the properties of insulating material over a range of service temperatures. Many laboratories are beginning to obtain these data and are overcoming the initial difficulties of making reliable measurements at elevated temperatures. We believe a good start has been made by du Pont in developing property data for "Teflon" for a range of temperatures. The next several figures present these data. You will note that in some of the figures, we have included data on other thermoplastic materials for comparative purposes.

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In figure 8 we have plotted the dissipation factor and dielectric constant versus temperature. Note that the extremely good initial values for "Teflon" remain constant over the full temperature range.

FIG. 8

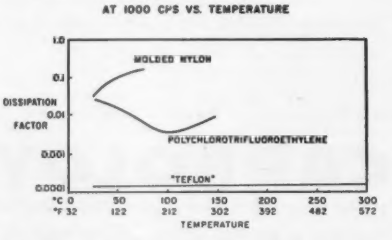


Figure 9 shows dielectric strength as a function of tempera-

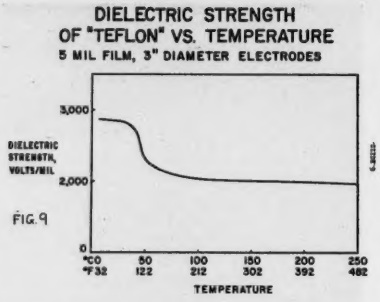


FIG. 9

ture. There is a sharp reduction in dielectric strength beginning at approximately room temperature but levelling out between 50 and 75°C. and then remaining essentially constant up to 250°C. This reduction coincides with a slight physical alteration in the solid state of "Teflon", sometimes referred to as a second order transition point.

★ ★ ★

In addition to adequate dielectric properties, many applications require the combination of good dielectric characteristics and physical properties. Thus in Figure 10 tensile strength of several materials is plotted versus temperature. You will note that the tensile strength of "Teflon" decreases slowly with temperature as compared to the quick reduction for the other materials shown. "Teflon" also has a reasonably good tensile strength even at 250 and 300°C.

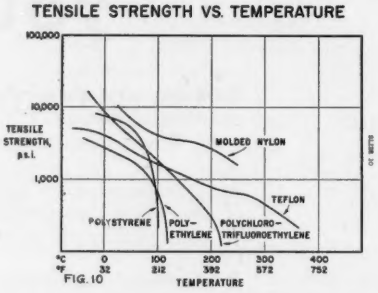
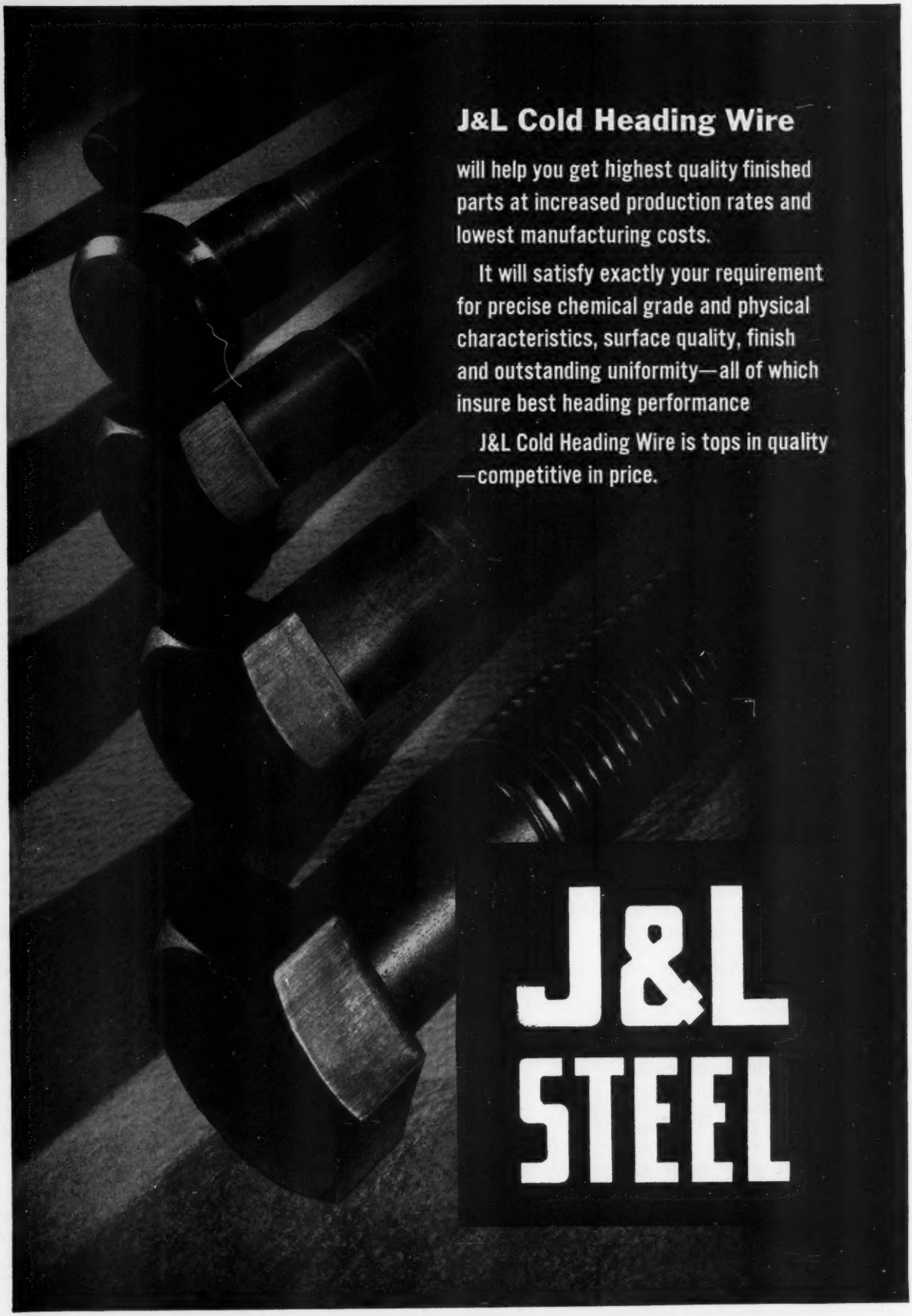


FIG. 10

The flexural modulus versus temperature curves are shown for several materials in Figure 11. Again you can see that the curve for "Teflon" has the least slope and that the resin still has a good modulus at temperatures of 250 and 300°C.

★ ★ ★

Values for the elongation of "Teflon" at various temperatures are presented in Figure 12. Notice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FLEXURAL MODULUS VS. TEMPERATURE

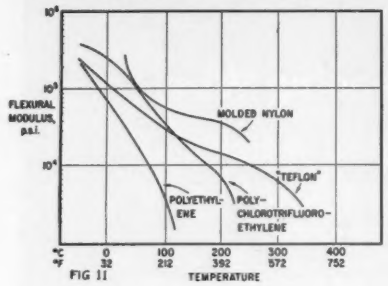

FIG 11

ELONGATION OF "TEFLON" VS. TEMPERATURE

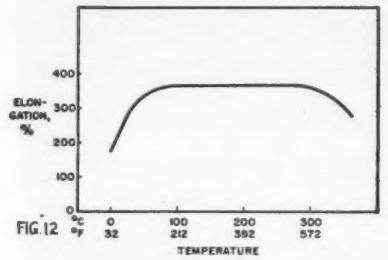

FIG 12

the unique flat portion of this curve and the high values for elevated service conditions.

★ ★ ★

These two sets of data—heat aging at 250°C. and mechanical properties versus elevated temperatures—show clearly and conclusively that "Teflon" is placed properly in Class C for applications at temperatures in excess of 180°C.

Identification

One requirement for many forms of wire insulation is that of easy and quick identification. Striped wires have been available in other wire insulations, such as vinyls, for several years, but the inks used for other conventional insulations were not suitable for wire insulated with "Teflon". Until recently, this restricted the use of "Teflon". Now, however, a full line of inks designed specifically for "Teflon" has been developed and is commercially available. The colors are distinct, non-fading, and do not rub off. This is another development leading to the broader use of "Teflon" for wire insulation.

Improvements in Fabrication

New developments in the fabrication of "Teflon" is a complete subject in itself and will not be discussed at this time since fabrication techniques have been covered adequately in recent publications and in technical bulletins offered by the Polychemicals Department of the Du Pont Company. It will suffice to say here that "Teflon" now can be applied to wire at commercial rates in all wall thicknesses from 0.25 mil to 500 mils.

Economics of Use

We would like to enlarge upon our earlier comment that "Teflon" as a wire insulation is becoming more attractive economically. This is being accomplished by three means. First, there has been a steady decrease in the price of "Teflon" since it was first introduced. Second, both the du Pont Company and the wire coaters have been remarkably successful in their efforts to improve the methods for applying "Teflon" to wire. Machine speeds, yields, and efficiencies have been increased and new techniques have been developed. Third, more and more property and design data are available to the design engineer. He can design to use thinner walls because of the confidence he can have in the superior electrical properties of this resin. In addition, he can use a smaller unit because "Teflon" will permit higher operating temperatures.

★ ★ ★

The next section of this paper will suggest to you applications for wire insulated with "Teflon" based on this more attractive competitive position.

Applications for Wire Insulated with "Teflon"

Magnet wire enameled with "Teflon" tetrafluoroethylene resin is being used in increasing quantities for aircraft control motors, for fractional and small integral motors to be used in chemical plants, and in areas where the ambient temperature is high. "Teflon" also enables the designer to achieve greater horsepower in a given size motor. Another use for this magnet wire is in electronic transformers. There is a growing need for these in jet aircraft, in rocket work, and in signal devices. Again excellence in dielectric properties plus high service temperature limits spell "Teflon".*

★ ★ ★

Hook-up wire is another growing application for "Teflon", representing sizeable business for several companies. This type of wire is coated with "Teflon" by one of three processes—extrusion, taping, or calendering. Uses for hook-up wire are primarily for aircraft control wire, harness wiring, rocket and missile wiring and for connection of electronic components. In addition to the dielectric properties, "Teflon" can compete with other insulating materials because it simplifies soldering hook-up wire to terminals. "Teflon" now makes it possible to design with terminals close together because the hot barrel of the soldering irons will not harm "Teflon" as it would other organic insulating materials.

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Wire of this type also is finding application for motor lead wire and for other electrical equipment where toughness, low temperature flexibility, high service temperature, or chemical resistance is required.

★ ★ ★

"Teflon" has been used as the dielectric in coaxial cables for some years. Process improvements for extruding "Teflon" as the primary insulation have resulted in appreciable growth in the use of such wire. A new coaxial cable development is the use of miniaturized coaxial conductors. This commercial use has been made possible largely through the development of new techniques for applying "Teflon" to wire. An ever-increasing market for this construction is found in the television and radar fields. An attractive economic feature of this construction which enables "Teflon" to compete with other dielectrics is the much thinner wall thickness of the insulation permissable with "Teflon".

★ ★ ★

In addition to the applications cited earlier there are a host of

* Information on wire enamels based on "Teflon" can be obtained from the Fabrics and Finishes Department of the du Pont Company.

(*Please turn to page* 815)

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Properties and Uses of Pure Molybdenum Disulfide As A Lubricant

by Alfred Sonntag, President
The Alpha Molykote Corporation
Stamford, Conn.

For many drawing and forming jobs, the addition of this substance has been shown to be advantageous. The author stresses the necessity, however, of using a pure molybdenum disulfide, as otherwise the hoped-for results may not be obtained. In this article he describes the material and its properties to give mill men a background of specific information.

Lubrication by Solids

Although over 50% of all the energy produced in the world is wasted on friction, lubrication is not yet recognized as a Science in its own right. It draws its talents from the fields of Physics, Chemistry, Metallurgy and Engineering, because lubrication roots in all these fields. Scientific lubrication literature is very impressive in that it reveals a complexity of lubrication phenomena which is not generally suspected. This inherent complexity is confounded by the fact that there is no standardized terminology, each field of science introducing its own terms and concepts. As an example, a contributor with a metallurgical background, who would ordinarily refer to molybdenum in steel as an alloy, may refer to molybdenum disulfide on a bearing surface as a "contaminating film"; in fact, other solids on the surface, no matter how much they reduce friction, become "contaminants", and a lubricant on the surface may not be referred to as such unless it contains a liquid. It may be interesting to speculate on how much the development of alloy steels might have been retarded if we had referred to our alloying materials, chrome, moly, nickel, etc., as contaminating materials. Whatever retarding effect lubrication terminology may have had on the general appreciation, recognition, or the development of solid lubricants, or how much it has contributed to the general confusion is difficult to evaluate. It appears more practical to condense the many cautiously and confusingly phrased observations with reference to the value of solid lubricants into the factual and basic statement that:

E.P.* or Boundary Lubrication, Without the Participation of Solid Lubricants, is Practically Impossible

Whether we rely on s o l i d lubricants which are already on the surface, or suspended solids carried into E.P. areas by liquids, or solids manufactured by E.P. additives in chemical reaction with the bearing surfaces, appears to be immaterial in this basic concept.

★ ★ ★

Were it not for the fact that all base metals protect themselves more or less efficiently with solid lubricants, represented by thin oxide films that develop within a few minutes after metal cutting or shearing, practically all our machinery would cease to run.

★ ★ ★

Once we absorb and appreciate fully the fact that natural solid oxide films reduce friction, galling and welding of most metals by rather substantial amounts, it is very logical to think more about trying to improve on nature's own defensive solids by alloying or supplementing them with more highly qualified solid lubricants.

★ ★ ★

With few exceptions, friction between "clean" metal surfaces is astoundingly high, and seizure occurs even at low bearing pressures. Fig. 1 shows friction test results with some unlubricated and meticulously cleaned metal specimens as reported by Bowden and Tabor.[1]

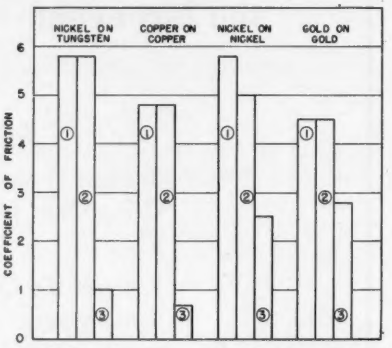

FIGURE 1. Friction test results with unlubricated metal specimens as reported by Bowden and Tabor. To remove surface films more effectively than it is possible in the presence of air, specimens were tested after prolonged heating and subsequent cooling in a vacuum. Coefficients of friction are shown in column 1. Results after admission of pure hydrogen or nitrogen are shown in column 2, and column 3 shows the results after a trace of oxygen was admitted. The largest portion of the drop occurred within a few minutes, reaching the recorded values within 10 to 20 hours.
Considerably higher friction values and large scale seizures are reported on metals still more thoroughly cleaned.

Observations confirm that welding and seizing can take place even at low bearing pressures, depending primarily on the cleanliness of a surface. They also point to the significance of surface oxides. Such clean surfaces are also produced on bearing surfaces if small surface ridges are sheared off or abraded, and in most cases protecting oxides do not have sufficient time to form.

★ ★ ★

This significance of natural oxide films, illustrated in Fig. 1, also furnishes at least a partial answer to the galling, welding and seizing characteristic of metals designed to resist oxidation—stainless steels,

* Extreme Pressure

[1] "The Friction and Lubrication of Solids" by F. P. Bowden and D. Tabor. Oxford University Press, London.

for instance—and implementation of surface oxides by other solids. MoS_2, in this case, has been a highly successful remedy.

★ ★ ★

In expressing preference for lubrication by liquids, engineers visualize a liquid as completely separating the mating surfaces, a condition which is obtainable only by hydrodynamic lubrication. How far we are removed in most practical applications from this ideal becomes evident by comparing, for orientation, average coefficients of friction.

★ ★ ★

For full hydrodynamic lubrication, the coefficient of friction is somewhere in the vicinity of .002. As soon as complete separation of bearing surfaces by liquids is interrupted, and solids begin to contact, the coefficient of friction moves by a factor of 50 into the vicinity of .1. It is in this latter group that we find the majority of practical applications.

★ ★ ★

This dependence on lubrication by solids and the significance of developments in this field may be expressed differently by pointing out that full hydrodynamic lubrication already permits conversion of energy with an efficiency of approximately 99.8%, but the world's energy losses due to machinery friction are estimated at approximately 50%. In most practical applications, complete separation of surfaces by liquid films is impossible. The best we can hope for is partial support by liquids and lubrication by solids, and as bearing pressures rise or sliding speeds drop the function of the liquid is reduced to that of serving as a convenient means to distribute frictional heat, and as a carrier to move solids or chemicals which will manufacture solids.

Molybdenum Disulfide

Molybdenum disulfide, MoS_2, which resembles graphite in appearance, is a mineral and is the primary source for molybdenum. The largest known ore deposit with sufficient MoS_2 concentration to justify economically commercial exploitation is in Colorado. Concentration in these ores averages approximately ½ of 1%.

★ ★ ★

During the past four years this natural MoS_2 has solved an increasing number of tough lubrication problems.

★ ★ ★

One synthetic grade has been tested, which proved to have no lubrication value.

★ ★ ★

MoS_2 crystals form in hexagonal units, each containing two molecules of disulfide. (See Figure 2)

★ ★ ★

The basis for the libricity of molybdenum disulfide lies in its unique molecular structure. Each lamina of the compound is composed of a layer of molybdenum atoms with a layer of sulfur atoms on each side. (See top of Figure 3). One of these laminae adheres strongly to metal surfaces,

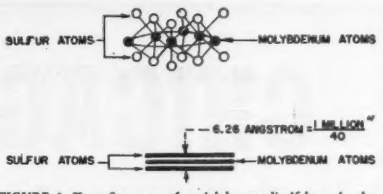

FIGURE 3. Top: Structure of molybdenum disulfide molecule; Bottom: Functional illustration of laminar structure.

and we assume that strong atomic bonds between sulfur and metal account for this. The other laminae slip easily because of the weakness of the sulfur-to-sulfur bond. According to one theory, this weakness is due to the relatively great distance between sulfur atoms.

★ ★ ★

Since the basic molecular structure of MoS_2 accounts for its function as a lubricant, this functional behavior can best be visualized by non-physicists if we compare a molecule of MoS_2 with a slice of bread buttered on both sides, (See bottom of Figure 3). The bread represents the molybdenum atoms and the butter represents the sulfur atoms. Such a structure has a tendency to lie flat and stick to a surface, and since the shear strength of butter is weak, stacks of vertical layers will laterally slide on each other.

★ ★ ★

As the thickness of one molecule is 6. 26 angstrom[2], or approximately 1/40th of a millionth of an inch, a surface deposit 1-millionth of an inch thick may theoretically consist of up to forty molecular layers with thirty-nine sliding or cleavage planes.

[2] Calculated from data in "Inorganic Chemistry" by J. J. Mellor.

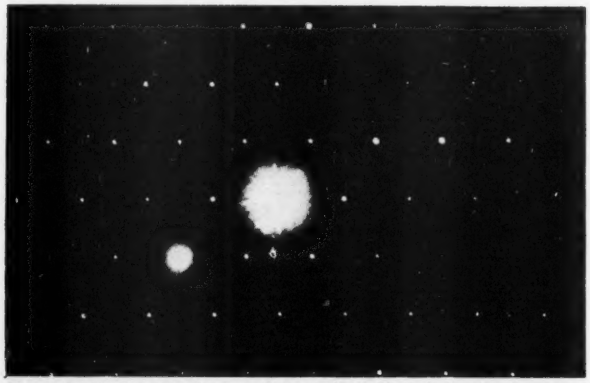

Figure 2—Electron-interference photograph of MoS_2 indicating hexagonal structure (by R. Bosch, G.M.B.H., Stuttgart, Germany). * * * *

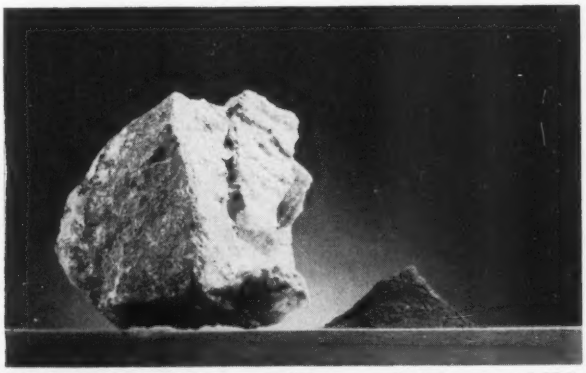

Figure 4—Typical molybdenum disulfide ore at the left, extracted MoS_2 at the right. * * * * * * * * * * * * * * * *

CHICAGO IN NOVEMBER!

Yes, that's the time and place for all good wire men to be for the

ANNUAL CONVENTION

of

THE WIRE ASSOCIATION

It will be held at the old stand — the La Salle Hotel in Chicago, Ill. — November 14th through 17th.

Preliminary reports from the Program Committee indicate a bigger and finer program of papers and special events that will make this meeting noteworthy.

Two plant tours through wire mills not heretofore visited by our group will add to the interest of the Convention to you this year. Details coming soon.

General Program Chairman is **John A. Moritz, Jr.**, President of Standard Industrial Compounds Co., Chicago; heading the Ferrous Program Committee is **Stewart S. Gray,** Asst. Vice President, Union Wire Rope Corp., Kansas City; and Chairman of the Non-Ferrous Program Committee is **Benoit J. Sirois,** Metallurgical Engineer, Phelps Dodge Copper Products Corp., Elizabeth, N. J.

Today is the time to make your arrangements to attend. Members will receive copies of the program and hotel reservation cards by mail.

THE WIRE ASSOCIATION

RICHARD E. BROWN, Executive Secretary

453 MAIN STREET • **STAMFORD, CONN.**

MoS_2 is slightly softer than graphite. It ranks 1-1.5 on Mohs scale.

★ ★ ★

The specific gravity is approximately 5, about twice as heavy as graphite. Since the sulfur is in chemical combination, it does not react on metals like free sulfur.

★ ★ ★

It has a natural affinity for tenacious adherence to metal surfaces. Experience indicates a strong molecular bond to metal surfaces and removal of the underlying materials appears necessary if, subsequently, surfaces must be coated by plating.

★ ★ ★

Figure 4 shows a typical piece of this ore with the molybdenum disulfide as a small heap on the right side. Traces of MoS_2 are also found in copper ore, and have been recovered as a by-product in rather substantial amounts during the past decade.

Purity

Purity cannot be over-stressed. While knowledge of the lubricating properties of MoS_2 may date back to 1764, sufficiently and consistently pure samples were not commercially available until about 1948. Even now, the designation MoS_2 does not assure suitability for any or all lubrication purposes. The entire development has been handicapped by the fact that grades containing as much as 15% abrasive material may be labeled "Molybdenum Disulfide" on laboratory shelves and in chemical supply houses. Even military specifications written for a lubricating grade of molybdenum disulfide do not exclude the presence of abrasive matter. It is for this reason that the author's company which has pioneered in the development of commercial lubricating grades of MoS_2 of high purity, found the adoption of a trade name a most essential distinction. Many potential uses for MoS_2 are still suffering from erroneous impressions resulting from disappointments with impure grades.

MoS_2 Resists Pressures Far Beyond the Yield Point of Any Metal

In Fig. 5 test results are reported for pressures up to 470,000 psi. There are large variations in the coefficient of friction which appear to be based on the quality of the MoS_2 coating on the specimen surface. Lowest values reported by Boyd and Robertson (4 on the chart) are traceable to the density of the MoS_2 layer on the surface. With the exception of 5 (on the chart), tests show decreasing friction with higher pressures. Spengler[3] believes that increased pressure forces more MoS_2 into pre-

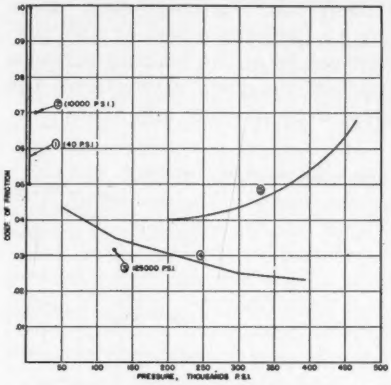

FIGURE 5. COEFFICIENTS OF FRICTION

1. Static friction 40 psi, MoS_2 powder, and MoS_2 containing liquids, various metal combinations. (Bureau of Standard Journal of Research Vol. 46, 1951)
2. 10,000 psi, Press Fit Tests MoS_2 (Molykote Type Z). Polished hardened steel mating surfaces. 6" per min. (A. Sonntag, IRON AGE Feb. 8, 1951)
3. 18 and 50% MoS_2 by weight in silicone, 125,000 psi, constant coefficient for velocities 1,000 to 16,000 feet per min. (NACA Research Memorandum RM 51D20, 1951)
4. Hardened Steel (63C) mating surfaces lapped to about 2 RMS micro inches. Speed very slow ½ RPM of small diameter specimens. J. Boyd and B. P. Robertson, Page 51-59, Transactions A.S.M.E. Jan. 1945)
5. Private Communication, Max Plank Institute, Dusseldorf, Germany, .53 carbon steel wire drawing tests; MoS_2 (Molykote Type Z) powder on a lime-coated wire. Curve represents 16 successive reduction draws. 1.64 feet per second.

ferred orientation on the surface, but an explanation may also be found in the theory of molecular attraction, according to which increased pressure forces a closer approach of MoS_2 molecules, thereby increasing repulsive forces between them and lowering the resistance to shear. Increased friction reported by 5 (on the chart) may be explained as follows:

MoS_2 powder was in the draw box to be picked up by the wire. The surface roughness of the lime coating on the wire permitted a liberal pickup of MoS_2 in the first draw, and less and less MoS_2 was picked up in successive reduction draws as the wire surface became smoother.

[3] "Molybdan Disulfid" by G. Spengler, March, 1954, issue of "Erdol und Kohle," Hamburg, Germany.

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The magnitude of the low friction values reported by Boyd and Robertson becomes the more striking if we compare them with sliding on ice, for which under the most favorable conditions values as low as .03 have been reported, comparing with .03 and better for MoS_2, at pressures in excess of 200,000 psi.

MoS_2 is Thermally Stable, Retaining Its Lubricity From 300° to 750°F. In Air And Up To Over 2000° F. In The Absence of Air

This is a significant feature by comparison with other E.P. lubricants or additives.

★ ★ ★

E.P. lubricants, relying on liquid chemical additives, are designed for a certain bearing metal combination and require minimum temperature for chemical reaction in order to produce by corrosion solid lubricants of low shear strength, and in most slow-speed operations the frictional heat developed is insufficient to initiate this chemical attack.

★ ★ ★

Fatty acids are excellent extreme bearing pressure agents, but lose their effectiveness either at the melting point of the acid or at the softening point of the metallic soaps formed (104° to 470°F.). Since their effectiveness also depends on the ability to form metallic soaps by chemical reaction with the surface, efficiency also depends on the type of bearing metal used.

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In contrast, the E.P. properties of MoS_2 are inherent in the material itself, and its effectiveness, therefore, is independent of bearing metal combination and of temperature within its own range of thermal stability.

It Is Chemically Stable And Is Attacked by Only A Few Strong Acids

It does not dissolve in cold or boiling water, or in solvents, petroleum oils or synthetic lubricants.

In the presence of pure oxygen it oxidizes at room temperature. It resists the attacks of most acids except Aqua Regia, boiling concentrated hydrochloric acid, fluorine and chlorine. This degree of inertness is particularly significant in applications on chemical machinery and equipment and where lifetime lubrication is considered.

Industrial Applications

Only such uses are listed where the margin of improvement can be expected to be large. The method of applying MoS_2 varies with the application and the results are based on a variety of MoS_2 lubricant compositions.

★ ★ ★

1. EXTREME BEARING PRESSURES (high friction, galling, seizing).

Severe cold forming, including wire drawing; metal cutting where the friction component is a substantial part of the total cutting force—tapping, for instance; and the cutting of metals which do not oxidize readily (as is the case with stainless steel) or have a tendency to weld or smear.

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It is also valuable in toggle joints, cams, gears, threaded connections, power screws, lathe centers, steady rests and in new machinery during the run-in period.

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2. EXTREME TEMPERATURES (high and low).

Threaded connections or other sliding parts on internal combustion engines; steam and gas turbines; jet engines; refrigeration machinery; aircraft; plastic molding presses; military weapons and equipment; oven chains.

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3. FRETTING

Usually experienced wherever reciprocating motion takes place. A large number of successful applications, including some very obstinate cases of fretting on splined shafts, have been reported. Usually a high concentration of MoS_2 in grease form is used.[4] For reciprocating ball bearings, a lower concentration of MoS_2 in grease[5] increases fatigue life.

★ ★ ★

4. HIGH STARTING FRICTION (friction at rest), instrumentation, fine adjustments.

Actual contact pressures existing at high spots, when bearing surfaces are at rest or in slow motion, are generally underestimated. Fig. 6 shows data by Bowden and Tabor.[1] Actual contact areas of two ground and lapped steel mating surfaces were measured electrically at various loads upon them. Real pressures at the contact points of the bearing surfaces reached the yield strength of the steel even at very low loads.

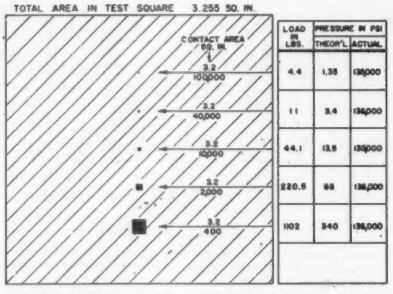

FIGURE 6. Apparent area of contacting steel flats is represented by large shaded area. Real contact areas at various loads shown to scale by solid black squares. Table gives loads with corresponding values for theoretical and actual bearing pressures.

When sliding friction members are at rest, liquid lubricating films disappear by leaking out. Even if we assume that small amounts of liquids can be trapped and completely sealed in by an unbroken solid ridge, their contribution to reducing the load on the contacting solids at rest is small considering the high compressibility of the liquids versus the solids. It takes a high starting force to break the parts loose and re-establish a liquid or semi-liquid film. Galling often occurs during these breakaway starts. This characteristic often interferes with fine increment adjustments on machine tools, on measuring machines and in instruments. MoS_2 separates contacting high spots and with its low static friction at the extreme pressures existing, it reduces starting force appreciably and counteracts galling. For this reason many plants assemble all new machinery with MoS_2 lubricant compositions, regardless of other lubricating compounds used during service. It is a cheap protection against friction surface damage during the wear-in period.

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On fine machine tools, measuring machines and instruments, where close tolerance and minimum backlash requirements present seizing problems, MoS_2 has been a real help. In many cases, parts can even be fitted with light press fit tolerances and still slide easily without galling.

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5. COLD FORMING AND WIRE PROCESSING

Many successful practical applications in the field of cold forming include: spinning, thread rolling, coining, stamping, punching, cold heading, and the drawing of tubing and wire. Typical benefits reported cover:

A reduction of metal pick-up and scoring of forming tools or dies.
Increases in tool and die life.
Increased forming speed.
Reduction of power required to form.
Improved surface finish of manufactured product.

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Some incidental advantages have been reported by wire users where the minute MoS_2 coating left on the wire after drawing has aided materially in cold heading and spring forming operations. This beneficial side-effect should also apply to wire used for thread-rolled screw products, where it not only provides improved life of thread-rolling tools and surface finish, but also imparts anti-seizing properties to the end product.

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Wire mills have reported favorably on the use of MoS_2 in drawing such materials as stainless steel, copper alloys including ISOTAN wire (54% Cu, 43% Ni, 3% Mn), spring steel wire, and common coarse steel wire. In most cases the

(*Please turn to page* 816)

[4]"Molykote Lubricants," Bulletin #100, The Alpha Molykote Corp.
[5]Bulletin #101, The Alpha Molykote Corp.

Hot Dip Galvanizing Is A Science

by Wallace G. Imhoff, President
The Wallace G. Imhoff Company
Van Nuys, California

Part VI

This is the sixth and final installment of the series of articles by the author on galvanizing. The material covered in this series covers a period of two years of research work and has covered the several principles of galvanizing in such manner that any company can check them against their own plant practices. This article is a review and discussion of the principles set forth in the preceding installments.

Before illustrating that under normal practical plant operating conditions, with all the basic principles operating the same in all plants, it now will be of advantage to collect in a clear and brief summary, all of the principles in review. This will furnish a background to understand why, with one single kind of an article, no two commercial plants, even though operating under the same galvanizing principles, get the same results or use the same operating conditions. It is only through order and system, that all scientific principles can be seen and understood.

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1. The first principle was that "the higher the galvanizing bath temperature, the heavier the zinc will be deposited as galvanized coating." This is the general relation between bath temperature and zinc deposited. As more detailed subdivisions of this general principle we note the following facts: a) All of the curves, or graphs, for all temperatures have the same general trend upward from low to high metal deposit; b) The higher the temperature, the heavier are all the deposits on the curve. To illustrate this point, at 820° F., and 40 seconds submersion time, the zinc deposited is 19.00 grams, while at 880 degrees F. the same gage sheet for the same submersion time in the zinc bath shows 25 grams of zinc deposited on another sample of exactly the same base metal. So this shows that there is not only an increase in metal deposited for all temperatures, but that for the same submersion times, there is more zinc deposited the higher the bath temperature: c) The third feature seen on all the graphs for all the different temperatures shows that for each temperature the zinc deposit increases up to a submersion time of 60 seconds, and then all curves show a decrease in zinc deposit for the next ten seconds to 70 seconds submersion time, when they once again start upward and show an increase of zinc deposit. The lower temperature zinc deposit graphs show lighter zinc deposits than the high temperature graphs. Here we have the general principle and three subdivisions, or variations of the same principle.

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2. The second general principle was "the heavier the gage of the base metal, the heavier the zinc will be deposited as galvanized coating." This principle is illustrated when at 40 seconds submersion time a zinc deposit of 22.60 grams is found, and for a much lighter gage and the same submersion time of 40 seconds, only 18.75 grams of zinc are deposited on a 30 gage sheet. This makes two general variables — all bath temperatures and all gages of base metals. The different combinations of just these two general principles over a large range can give almost countless results, but the basic principles themselves never change.

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3. The third principle is "it is a definite scientific principle that the longer the submersion time in the bath, the heavier the zinc will be deposited as galvanized coating." Since the submersion time may be only a few seconds up to 5 or 10 minutes, as is the case with heavy ship plates, this set of variables alone make the general picture extremely complicated. If the submersion times vary by .05 hundredths of a minute, that makes a total of 200 results; if 10 seconds, 100 results, and, if measured in seconds, 5 seconds give 12 different results per minute, or 120 results for 10 minutes. Add to all these variables the many variables of temperature and different gages of base metal, and the results can hardly be counted. That is the reason for the confusion that may develop if the basic principles are not known.

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4. The fourth scientific principle of galvanizing is, "the longer the pickling time, the heavier the zinc will be deposited as galvanized coating". Pickling time varies with the kind of base metal, the condition of the surface of the base metal, the acid strength, the kind of acid, the bath temperature and whether an inhibitor is used or not. Here are another six variables to be used with all the other variables. The single results appear to be becoming endless as the number of variables increase.

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5. It is a definite scientific principle, "that the withdrawal time directly affects the weight of zinc deposited as galvanized coating. A fast withdrawal time drags excessive metal out of the bath with the article; too slow a withdrawal time, under the correct minimum, increases the weight of zinc deposited as galvanized coating due to the alloying action of the molten zinc with the base metal."

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6. "The kind and character of the base metal directly influence the weight of zinc deposited as galvanized coating." Cast metals,

such as malleable iron and cast iron castings take on a heavier zinc deposit as coating, than formed, rolled or forged base metals. Mechanical work done on the base metal, annealing, etc., all tend to vitally change the amount of zinc deposited as galvanized coating.

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7. "The more heavily the surface of the metal is corroded, the greater the amount of zinc deposited as galvanized coating".

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8. "The rougher the surface condition, the heavier the zinc will be deposited as galvanized coating". Both principles 7 and 8 are factors which change the pickling time (6).

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9. "A new galvanizing bath always gives a lighter deposit of zinc as galvanized coating than a bath in use for some time". The specific gravity of new zinc is 7.14; that of zinc saturated with iron is 7.30; and an old bath that has been operated for some time and been drossed will show a specific gravity of the dross of 7.40 and over, depending upon how high the bath temperature has gone. Thus there is considerable difference in the weight of zinc deposited as coating with new zinc and old zinc.

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10. "As the iron in the galvanizing bath increases, the weight of the zinc coating increases."

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11. "When a hot dip galvanizing bath contains only iron and aluminum as impurities, the weight of coating increases rapidly with the deterioration of the bath."

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12. "The metals lead, tin, and cadmium tend to decrease the weight of zinc deposited as coating; thin out the bath, give a thinner coating, and a lighter zinc deposit."

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13. "It is a definite scientific galvanizing principle, that as the production increases, the weight of zinc deposited as galvanized coating increases". In (1) it was stated that an increase of temperature of the bath increased the weight of zinc deposited as galvanized coating.

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14. "It is a definite galvanizing scientific principle that an increase in production must be accompanied by an increase in the bath temperature". If this is not done, then the bath temperature will start to drop because more cold steel is entering the bath, as production is increased.

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15. "One, two, or more scientific principles are always operating at once, some operating to increase the weight of zinc deposited as galvanized coating, and others operating to decrease the amount of zinc deposited as galvanized coating. This tends to complicate and confuse what is actually happening in the net result. The actual amount of metal deposited is the compromise, or final result of all of the opposing forces and variables involved.

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16. "It is a scientifically proven fact, that if all of the metals are kept track of both before and after galvanizing, there is no metal loss by evaporation." Weigh scales must be accurately checked, and all materials and by-products must be accurately analyzed to obtain their metallic contents. Even metal lost on the floor, on the tools, and in water quench tanks, must all be accounted for to obtain a perfect metal balance.

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17. "It is a definite scientific hot dip galvanizing principle that the lowest costs, the highest quality, and the highest production, based on the highest quality, are obtained, when all of the hot dip galvanizing principles are operating in harmony and correctly."

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The basic principles of galvanizing just cited operate the same in all fields of hot dip galvanizing. There are two conditions in practice that must be taken into account, namely: first, all galvanizing fields in which these basic principles are free to operate; and second, those fields that have been mentioned, such as sheets, wire, pipe, electrical conduit, etc., in which some of the principles are not free to operate. In studying and trying to find out what the basic principles of galvanizing are and how they operate, it is best to select a practical field of galvanizing in which all of the principles are able to operate freely, with no outside influence changing the true results. A standard 12-quart galvanized water pail is the simplest article by which all of these principles can be observed in behavior. The following technical data and information was obtained from a number of commercial hot dip galvanizing companies, all galvanizing the same kind of 12-quart water pail.

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Purpose:—The purpose of this experiment was to determine the average amount of deposited zinc on a 12-quart galvanized water pail under all ordinary conditions found in practice.

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Method of Procedure:—The method of determining the average zinc deposited on the water pails was as follows:—

Sixteen gross of 28-gage, O.P.C.R. black, ordinary, 12-quart, light water pails were purchased from a leading galvanizing company. These pails were shipped to the writer, and were weighed by him in the black condition. One gross of black pails was then shipped to each galvanizing company contributing to the research work. These pails were to be galvanized under the conditions in their plant and then returned to the writer. A questionnaire was also sent to each company to be filled out when the pails were galvanized, and this was sent with the pails to record the operating conditions in each plant.

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Just as soon as each gross of galvanized pails were received, the galvanized weight was immediately obtained. In addition to weighing the pails they were also graded on such points as affect the quality of the pail. Each company was given an arbitrary number to identify his pails. In order to avoid any error in mixing of pails each individual pail was marked with the owner's number as soon as his galvanized pails were received. Thus all pails lost their identity in the test and received impartial grading.

Results

The final results of this experiment are shown in the table opposite.

★ ★ ★

In grading the pails the rating of A was highest; a rating of B was medium; and a rating of C was low.

Detailed Discussion of Results

All the data was recorded on a large chart so that the data from the individual companies could be easily and quickly inspected. The results automatically fall into two main classifications: 1. The data on the questionnaires, and 2. the data derived from the examination and comparison of the finished galvanized pails.

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I. The data on the Questionnaires:

The comparison of the data on the questionnaires has conclusively proved a number of the results already discussed under the various galvanizing principles.

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In checking the various weights of pails, 6 companies weighed in the same as those found by the writer. Most of the weights varied by only 1/4 to 1/2 a lb. and the greatest variation was 2½ lbs.

★ ★ ★

The water on the pails varied from 3 lbs. to 9 lbs. with an average of 5 lbs. The scale weights (loss of weight in pickling) varied from 2 lbs. to 10 lbs. with an average pickling loss of 5.3 lbs. The dry pickled weights varied from 222½ lbs. to 229½ lbs. with an average of 225 lbs.

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The weight of zinc deposited as galvanized coating varied from 63 lbs. to 89 lbs. with an average of 75.4 lbs. of zinc per gross of galvanized pails.

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The strength of the pickles were from 1½ to 12%. The pickling baths were evenly divided as to OLD and NEW solutions. The temperatures of the pickling baths varied from 115° F. to 170° F., and the pickling time varied from 14 minutes to 2½ hours. The time the pails were exposed to the air between pickling and aciding varied from 1 minute to 1½ hours. The muriatic acid strength varied from no acid used to 100%, the full strength of the commercial acid.

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The pails on the drain-rack at one time varied from 8 to the full gross, 144. The time the pails were exposed to the air between pickling and galvanizing varied from 5 seconds to 45 minutes. Practically all the pails were wet when galvanized.

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Coarse gray sal-ammoniac was used in the majority of plants although some fine grades were also specified. The flux was made light and fluffy by middlings, sawdust, glycerin, flour, bran and packing hay. The companies were evenly divided on the condition of the flux as to **old** and **new** flux.

★ ★ ★

The following brands of zinc were listed:—Hegeler Brothers, Bartlesville, Grasselli, Remelt, Eagle Picher, B. Z. Co., American Metal Company Athletic and Ideal, Quinton, Nassau, and Granby Select. Tin, antimony, aluminum and silver, were used as metal additions to the bath. The bath temperature varied from 800° F. to 895° F. In most companies a temperature of 850° F. was used for galvanizing.

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There were 10 single end and 6 double end kettles (pots worked at both ends). The fuels used were 10 coke, 3 coal, 2 oil, and 1 gas. The kettles were listed as drossed on the same day to 15 days before the pails were galvanized. The kettle operations varied from 10 hours a day to continuous operation day and night. There were 3, 4, and 5 men gangs on the kettles.

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The speed varied from 13 dozen per hour to 37 2/3 dozen per hour.

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The time from the drain-rack to the flux box varied from 1½ seconds to 6 seconds; through the flux box from 3 seconds to 17½ seconds; submersion time from 2 seconds to 36 seconds; and withdrawal time from 1½ seconds to 18½ seconds.

★ ★ ★

The items of importance that are suggested from the questionnaire are the following:—

1. **The shorter the pickling time the**

GRADE ITEM	COMPANY 1	6	9	10	15	18	21	24	26	29	32	34	39	40	44	46
1. General Appearance	B	A	A	C	A	A	A	A	B	B	C	C	B	A	B	A
2. Flux Spots in Top	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
" " Outside Top	A	A	A	B	B	A	A	A	A	A	B	A	A	A	A	A
3. Flux Spots, Bottom Inside	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
" " " Outside	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
4. Weight of Coating **	C	B	B	C	C	A	B	A	B	A	A	B	A	B	C	C
5. Spangle - Bright	X	X	X	-	-	X	-	-	X	-	X	-	-	X	X	X
6. Spangle - Dull	-	-	-	X	X	-	X	X	-	X	-	X	X	-	-	-
7. Spangle - Large	X	-	X	X	X	-	X	-	X	-	X	-	X	X	X	X
8. Spangle - Small	-	X	-	-	-	X	-	X	-	X	-	X	-	-	-	-
9. Adherence	C	A	C	B	C	C	A	A	B	B	B	B	C	B	B	C
10. Bends, Dents, etc.	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
11. Tong Merks	B	A	B	C	A	A	A	B	B	A	B	A	C	A	B	A
12. Rough Rims	A	A	A	B	B	A	A	B	B	B	A	B	B	A	A	B
13. Deposit in Chime	A	A	A	B	A	A	A	A	A	B	A	C	A	A	A	A
14. Drip Down Sides	A	A	A	B	A	A	A	A	C	A	A	A	B	A	A	A
15. Dross in Coating	A	A	A	A	A	B	A	A	A	C	A	A	A	A	A	A
16. Black Spots	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
17. White Spots	A	A	A	A	A	A	A	A	A	A	A	C	A	A	A	A
18. Scum in Coating	A	A	A	A	A	A	A	A	A	A	B	A	A	B	A	A
19. Zinc Points	A	A	B	A	B	A	A	B	A	B	A	B	A	B	B	A
20. White Clouded Coating	A	A	A	A	A	A	A	A	A	B	B	A	A	B	B	A
21. Speed **	B	C	B	C	B	C	C	B	A	B	C	A	B	C	C	C
22. Smoothness of Coating	B	A	A	B	A	A	A	A	B	A	C	A	B	A	A	A
23. Bare Places, Piled too Hot	B	A	B	A	A	A	A	A	B	A	A	A	A	A	A	A
24. Burnt Coating, Inside too Hot	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A

** A is 63 - 71 lbs. per gross 29 - 37 dozen per hour
B is 72 - 79 " " " 21 - 29 " " "
C is 80 - 90 " " " 13 - 21 " " "

INDISPENSABLE!

The 1955 Edition of the WIRE and WIRE PRODUCTS BUYERS' GUIDE and YEAR BOOK Of the WIRE ASSOCIATION

Thousands of changes in the listings of machinery, equipment, supplies, rods, wire and wire products. The only directory of everything of interest to wire men, this book is an indispensable reference with which to locate sources of supply when you are in the market to buy something.

The Year Book section is completely new. Contains the current directors and officers of the Association, the history of Association activities in 1954, a list of members as of February 1st, the By-Laws of the Association and lists of Medal Award, Certificate of Honorable Mention, Mordica Memorial lecturers.

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lighter the zinc deposited as galvanized coating. (Principle No. 4.)

2. The shorter the submersion time the lighter the zinc will be deposited as galvanized coating. (Principle No. 3.)

3. The lower the bath temperature, the lighter the zinc is deposited as galvanized coating. (Principle No. 1.)

4. Additional data of interest was that the weight of zinc deposited as galvanized coating varied from 63 lbs. to 89 lbs. with an average of 75.4 lbs. of zinc per gross of galvanized pails.

5. The speed varied from 13 dozen per hour to 37 2/3 dozen per hour with 20 dozen as the average speed per hour.

6. There were 10 single end kettle installations and 6 double end kettle installations listed. The lightest galvanized coating was made on a single end kettle; the average of all weights was lightest on the double end installations.

7. The lowest speed was 13 dozen per hour; the highest speed was 37 2/3 dozen per hour; there was a difference of 26 lbs. of zinc per gross deposited as galvanized coating at these two widely different speeds.

8. Both the lightest and the heaviest weights of zinc deposited as galvanized coating were made on the single end, coke-fired kettles.

★ ★ ★

II. A discussion of the examination and comparison of the finished galvanized pails.

In addition to ascertaining the weight of zinc deposited as galvanized coating, this collection of pails furnished an excellent basis for establishing a complete list of defects in the galvanized coatings.

★ ★ ★

Many of the pails examined individually appeared as though they should receive an extremely high rating, but on comparing them with all others on an equal basis of rating, the defect, although perhaps not prominent, was sufficient to change the value when the pails were compared with others for the same defect. The grade A was given as the highest rating; the grade B when the quality was not so good, and the grade C when the defect was distinctly noticeable.

★ ★ ★

A discussion of the individual rating will now be given.

★ ★ ★

1. GENERAL APPEARANCE: —The general appearance was the rating given to the appearance of the pails wnen they (the full gross 144) were spread out for inspection. Each gross was immediately numbered, and the pails separated so that each one could be picked up and examined alone if necessary.

★ ★ ★

2 and 3 — FLUX SPOTS:— There were very few flux spots on the pails as a whole, in fact, taking them altogether they were much better than the average pail in this particular item. They were examined at the top of the pail inside and outside, and at the bottom of the pail, inside and outside.

★ ★ ★

4. WEIGHT OF COATING:— The weight of coating was the weight of zinc figured from the data sent in on the questionnaires. Six of the weights given by the companies checked exactly with those found by the writer, and the majority of the others checked so closely that the weights on the questionnaire were accepted as final. The weight of the zinc deposited as galvanized coating varied from 63 to 89 lbs. per gross. The chief reasons for this wide variation seemed to lie in the pickling time, the length of submersion time, and the temperature of the spelter bath. The grade A was given for a weight of coating of 63 to 71 lbs. inclusive; a grade B for 72 to 79 lbs. inclusive; and a grade C for 80 to 90 lbs. inclusive.

★ ★ ★

5-6-7 and 8 — SPANGLE:—All kinds of spangles were represented in the entire lot of pails. As seen from the grade sheet tables no rating was given for the spangle since this seems to be largely a matter of taste and what the trade demands. There were large and small bright crystals and large and small dull crystals, and mixtures of the two.

★ ★ ★

9. ADHERENCE: — The aherence test consisted of cutting three small strips (1/2 x 1 inch) from different parts of the pail and bending them back and forth in a small steel bending machine through a 90 degree arc, first in one direction, and then after straightening, 90 degrees in the opposite direction. Three individual tests were made on each coating which were as follows:—

No. 1 was bent once back and forth through a 90 degree arc, first in one direction and then in the opposite direction after straightening.

No. 2 was bent twice back and forth through a 90 degree arc, first in one direction and then in the opposite direction after straightening.

No. 3 was bent three times back and forth through a 90 degree arc, first in one direction and then in the opposite direction after straightening.

The final grade was given from the results of all three bend tests. Some of the coatings possessed low adhering qualities.

★ ★ ★

10. BENDS, DENTS, ETC.:— All of the pails were received in good condition after being galvanized.

★ ★ ★

11. TONG MARKS:—This is a feature which should receive attention. There were a few companies whose pails did not have any tong marks on them. On the other hand the others ranged from a slight tong mark to a badly marred coating with deep dents in the sides.

★ ★ ★

12. ROUGH RIMS:—This defect is caused by allowing the zinc to drip and chill on the rim, and by scraping the rim. A large number of samples were smooth, but some of them had extremely rough, ragged edges on the rim.

★ ★ ★

13. DEPOSIT IN THE CHIME:- This defect is caused by the zinc running down to the bottom of the pail and collecting in a little pool before the bucket is removed from the peg, or rack. It is not found on hand-drained pails. Some of the pails were very rough and ragged on the outside lower rim due to this feature.

★ ★ ★

14. DRIP DOWN THE SIDES:— This defect is caused by excessive metal being carried out with the pail; when it chills and hardens it leaves a very rough and uneven coating. High speed production and quick withdrawal time usually cause this defect. In some of the pails this defect was very marked.

(*Please turn to page* 817)

Government Wire Production Information

New Process for Producing Titanium

Experiments with a new process for production of titanium metal, and a new method of obtaining titanium from impure scrap will be carried on under two contracts signed by the **General Services Administration,** according to **A. J. Walsh,** GSA Commissioner of Emergency Procurement.

★ ★ ★

One agreement is with **National Research Corporation** and **Monsanto Chemical Company.** Under it, the N.R.C. will test a new fused salt process for production of titanium, previous work having reached the point where larger scale operations are necessary for complete evaluation of the new process.

★ ★ ★

A pilot plant having a rated capacity of 1,000 pounds per day will be operated. The work is estimated to cost about $1,183,500. The Government will reimburse the firms but they will receive no fee for the work. The Government will get non-exclusive royalty free licenses on the inventions and patents which may be developed. The contract also contains provisions for repayment of the Government's investment should the process prove to be feasible and commercial production results within ten years.

★ ★ ★

The second agreement is with **Horizons, Inc.,** of Cleveland, Ohio. The company will regenerate titanium from impure scrap metal by using its patented process.

★ ★ ★

Often called the "wonder metal" because of its properties of strength and light weight, titanium is considered difficult to process because it easily becomes "contaminated" with other elements during production, resulting in substantial spoilage. The new process is designed to recover metal which would otherwise be substantially useless in scrap form.

★ ★ ★

Horizons, Inc., also will work without fee. Cost of the experimental operations is estimated at $96,500, which the Government will pay. However, should the work prove successful and the process be put into commercial production within ten years, the Government will be reimbursed for its investment and will receive non-exclusive royalty free licenses on inventions and patents which may be developed.

Government Instructions for Bidding on Korean Business

A new 12-page bulletin has been issued by the **Office of Small Business, Foreign Operations Administration,** Washington 25, D. C., containing instructions and general conditions for bidding applicable to invitations to bid on op-

MICROMETER PRECISION — MICRO-WELD TRADE MARK REGISTERED

MODELS J-3-S and J-4-S AUTOMATIC MICRO-WELD BUTT WELDERS

These welders are used for welding high and low carbon STEEL, and STEEL ALLOY wire, ranging in size from .020" to .160" diameter. All operations on these units, which include the clamping of the wire being welded, contacting the welding switch, and upsetting the weld, are made by a single downward stroke of the foot pedal. Welders for high carbon steel wire are equipped with the exclusive MICRO-WELD Dial indicating annealing device to facilitate the annealing operation of high carbon wire.

Standard equipment with these units include annealing dies, filing vise, light extension cord, and mounting on a 4-wheel truck. Special units can be furnished for crane mounting.

MICRO PRODUCTS CO.

20 NO. WACKER DR., CHICAGO 6, ILL.
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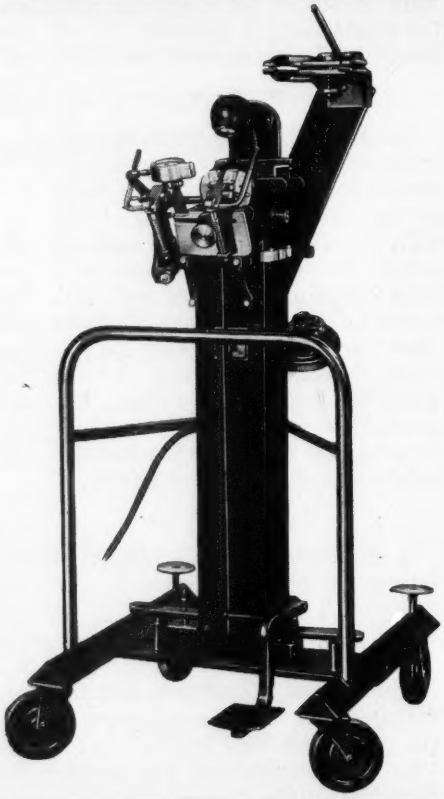


portunities to furnish materials, supplies and equipment needed by the Republic of Korea.

★ ★ ★

This is memorandum SBM No. 54-30 and supercedes the memorandum and supplements thereto issued on September 21 and December 1, 1954.

★ ★ ★

Copies may be secured upon application to the above-named agency.

Paint Practice Recommendations Published

Printed copies of Simplified Practice Recommendation R144-55, Paints, Varnishes, and Related Products (Colors and Containers), are now available, the Commodity Standards Division, Office of Technical Services, **U.S. Department of Commerce,** has reported.

★ ★ ★

This recommendation gives a maximum number of colors and sizes of container for a variety of oil paints, enamels, varnishes, water-thinned paints and related products. It covers trade sales items only. It was first issued in 1924 as a Limitation of Variety Recommendation, and in 1932 was converted to a Simplified Practice Recommendation. It has since been revised several times.

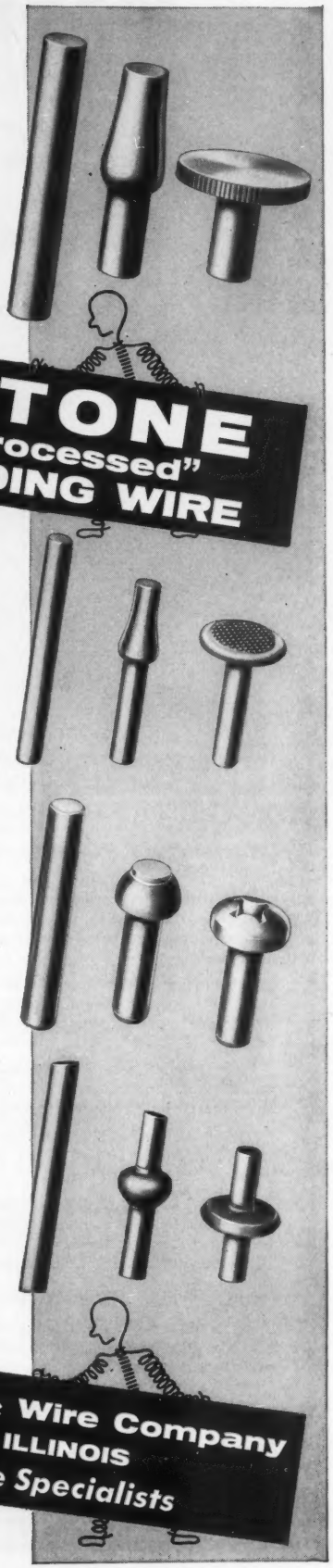
★ ★ ★

This revision will bring the recommendation in line with current needs and industry practice. It provides for an increase in the recommended maximum number of colors of six items of oil paints and related products, and four items of water-thinned paints and related products. The description of several of the items has been clarified as have the explanatory footnotes for certain items.

★ ★ ★

Printed copies of the revised recommendation may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D.C., for 5 cents a copy. A discount will be allowed on orders of 100 or more copies mailed to a single address.

Wire that's *BEST* for difficult cold heading



The terrific displacement of metal during the cold heading process requires a wire that's *processed specifically* to meet the exact requirements of the job.

In plants where Keystone "Special Processed" Wire is specified for difficult cold heading, production records show these valuable results: (1) increases the production rate which *lowers cost per unit;* (2) greatly prolongs die life which *reduces machine down-time and labor costs;* (3) provides higher quality finished products which *minimizes rejections and inspections.*

Call on our wire specialists for assistance on any problem concerning steel wire. Contact your Keystone representative or write direct.

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New WARDWELLIAN®

Pay-Off Stand

An improved Pay-Off Stand for delivering small diameter soft drawn wires from supply spools in the process of winding single or multiple ends on metal spools as supplies for WARDWELL RAPID BRAIDERS and other uses.

Maximum diameter wire approximately .012.

Due to the system used the wire strands can be payed off rapidly to deliver properly to the winding machine.

Supply spools are mounted in substantially vertical position to allow the strands to pay off over the spool heads.

Each strand of wire feeds around an individual tensioning roll adjustable for securing any desired tension.

This method of applying tension to each individual strand results in uniform tension on all strands.

A cylindrical guard surrounding each spool prevents interference between the strands during ballooning as they unwind from the spools. Guards can be raised and lowered for easy mounting and removal of supply spools.

Guides for wires are made of long-wearing Heanium material.

An auxiliary guide-stand for feeding strands to winder furnished with each Pay-Off Stand.

Stand will accommodate eight spools or can be extended for twelve supplies at slight additional cost.

Maximum diameter of supply spool head 8".

A standard set of eight spool-caps furnished with each stand.

Spool dimensions including diameter of bore must be furnished when ordering.

Weight of standard type for eight supply spools approximately 270 lbs.

Complete information on request

Ask about our other machines for braiding, shielding with wire, tape serving, yarn serving, asbestos serving, paper serving, armor serving and resistance wire serving.

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BRAIDING MACHINE CO.

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Representatives for Europe, British Colonies and Dependencies
JAMES MACKIE & SONS, LTD., BELFAST, IRELAND

To Sell Natdi Reversible Dies Abroad

Copperweld Steel International, 117 Liberty St., New York 6, N. Y., has announced that it has concluded arrangements with the **National Wire Die Company,** New York City, to be the exclusive export representative for the sale abroad of the Natdi, the reversible diamond wire drawing die.

CF&I's Morgan Works to be Moved to Palmer

Wickwire-Spencer division's Morgan Works of **Colorado Fuel & Iron Corporation** will move from Worcester to a $2,000,000 plant being erected in Palmer, Mass.

★ ★ ★

The works makes wire springs from wire produced at Palmer.

★ ★ ★

The change will affect more than 450 Worcester workers who are being urged to plan on moving to Palmer. The change will be completed before the year's end.

★ ★ ★

Wickwire-Spencer has operated the Worcester plant for 35 years.

★ ★ ★

Frederick G. Lindstrom, district manager, said the three-story factory and its machinery are now antiquated and too costly to produce on, in face of today's competition and there is no room to streamline production facilities.

★ ★ ★

The new Palmer plant is being erected alongside the present 1,000-man works on Route 20. Mr. Lindstrom said it is expected more employes will be used in the new plant than are now working here.

★ ★ ★

Mr. Lindstrom said that the new plant, for which ground has already been broken, will "be a streamlined-production facility and we have engineers studying the possibility of automation."

Rome Soap Offers New Line of Wire Drawing Compounds

Rome Soap Manufacturing Company, Sixth St., Rome, N. Y., who have been manufacturing soap for industrial applications since 1896, have developed and thoroughly field tested over the last two years a completely new line of wet and dry wire drawing lubricants that are giving excellent satisfaction in a number of leading wire mills in the drawing of steel, copper, aluminum and other metals. They are now available to all wire mills.

★ ★ ★

As a result of a recent reorganization of the management, **Frank W. Brown** was elected President; **Paul R. E. Goetz,** Treasurer; **James S. Brown,** Secretary, and **Carroll A. Murphy,** Sales Manager.

★ ★ ★

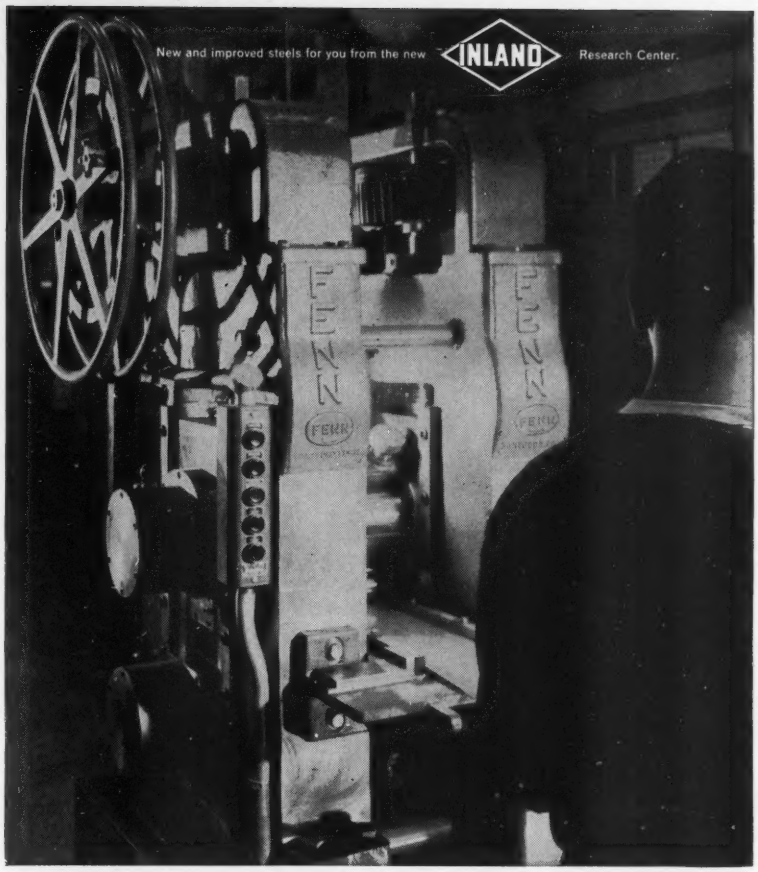
Mr. James S. Brown has been with the company for 35 years, Mr. Goetz has been plant superintendent and chemist for 32 years, and Mr. Murphy has had 13 years of experience with companies manufacturing lubricants and industrial chemicals. Mr. Frank W. Brown was re-elected to the presidency of the company whose management he has successfully directed for many years. The elections took place in March, 1955.

National-Standard Names Four New Officers

National-Standard Company has appointed four new executive officers. Named to management positions by the Niles, Michigan, firm are two new vice presidents, an assistant vice president, and an assistant to the president.

★ ★ ★

James A. Mogle, Jr. came to National-Standard Company in 1941 after receiving his master's degree in mechanical engineering from Illinois Institute of Technology. He was named purchasing agent in 1943 and director of purchases in 1949. In 1951, he became director of purchases and manager of operations, Niles Division. His new position is Vice President,



THIS PINT-SIZE ROLLING MILL MAY SAVE YOU KING-SIZE HEADACHES (AND MONEY TOO!)

At Inland, 'new ideas' are considered as vital a raw material in steelmaking as top grade iron ore and coal. Establishing reserves of this basic ingredient is a continuing job for Inland's research and development people. The new Inland Research Center in Hammond, Indiana, where Inland researchers look for better steels and more efficient ways to make them, is the most recent addition to Inland's 'new idea' resources.

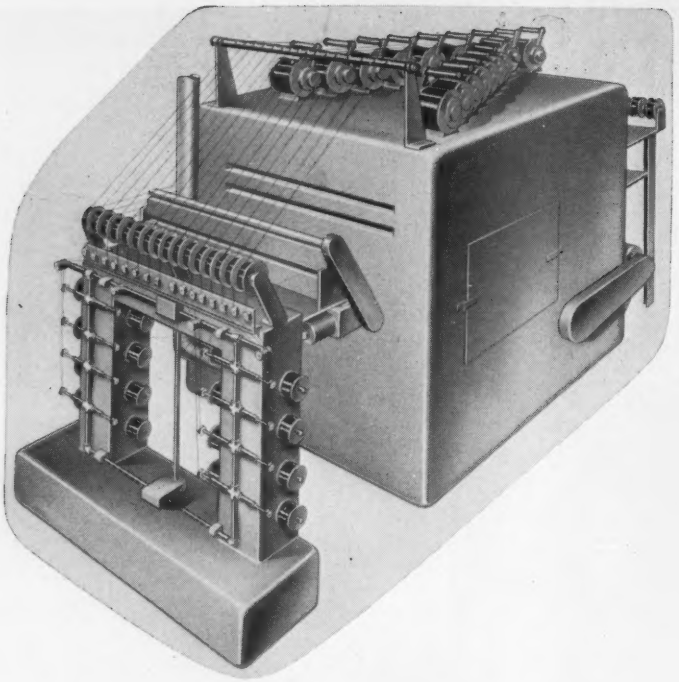
We at Fenn are pleased to quote the foregoing from a recent advertisement of Inland Steel Company of Chicago. We are especially glad that Inland found, in Fenn rolling mills, the precision, flexibility and rugged dependability demanded in their research projects.

Fenn will design rolling mills for all special applications, in a complete range of sizes, and will furnish all accessories. Fenn mills have extra bearing capacity to take higher horsepowers, and are designed for year-after-year accuracy —owning cost is exceptionally low.

FENN

PRECISION ROLLING MILLS—TURKS HEADS—WIRE SHAPING MILLS—SWAGING MACHINES—ACCESSORIES

The Fenn Manufacturing Company, 411 Fenn Road, Newington, Connecticut



Increased Enameling Speed with Minimum Wire Breakage

By incorporating advanced design techniques with years of wire enameling research, this new MOCO fine wire enameling oven offers advanced enameling speeds with a marked decrease in breakage. The result is a cost-cutting operation with increased production.

The equipment is competitively priced and combines versatility with simplicity. The high degree of skill formerly required in performing this operation has been reduced—control of the product is handled by the machine.

OTHER NEW FEATURES INCLUDE:

- Advanced design, offering low fuel consumption—less maintenance.
- A wide range of insulating materials may be handled.
- New rapid start-and-stop device increases production.

FOR MORE DETAILS . . .

Write or phone for this informative brochure which tells the *complete* story of this new MOCO fine wire enameling equipment.

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An experienced MOCO representative is near you—ready to aid in the solution of your wire enameling problems.

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PRODUCERS OF COMPLETE ENAMELING SYSTEMS FOR ALL WIRE SIZES

MICHIGAN OVEN COMPANY
425 BRAINARD ST., DETROIT 1, MICHIGAN

Purchasing and Reciprocal Relations.

* * *

Thomas H. Peace, new Vice President of Engineering and Operations, joined National-Standard Company in 1948 as a project engineer after he came to the Niles, Michigan plant from British Ropes, Ltd., to assist in development work. With British Ropes, Mr. Peace had broad experience in production engineering and works manager. At National-Standard Company he was promoted to director of engineering in 1954 before assuming his present position.

* * *

New Assistant Vice President, Bead Wire and Hose Wire Sales, **William D. Peace** came to National-Standard Company as manager of tire bead and hose wire sales in 1952. Previously, he was general manager of Johnson Steel & Wire Company's plant in Akron, Ohio.

* * *

George Hussey, Jr., came to National-Standard Company in 1942 after graduation from Williams College. Following his discharge from military service in 1946 he became personnel manager of the Niles Plant of the Company, moved on to become assistant manager of industrial relations in 1950 and Company Secretary in 1952. His new position is Secretary and Assistant to the President.

New Catalog on Corrosion Resistant Process Equipment

Catalog G-1, issued by **Haveg Corp.,** 900 Greenbank Rd., Wilmington 8, Del., describes a new material for process equipment, "Haveg 1810." This is a pure, unplasticized, rigid polyvinyl chloride, from which corrosion resistant tanks, pipes, fittings, valves, etc. are constructed to provide superior service in pickling, plating and other processing of metals.

* * *

Complete tables of properties and chemical resistance data are provided, together with tables of sizes and listings of all the many

forms in which the material is supplied.

★ ★ ★

Copies of this informative 12 page bulletin, illustrated in color, will be sent to interested persons upon application to the company.

Wire Cloth Unit Changes Name

The California Wire Cloth Corp., 1080 19th Ave., Oakland, Cal., a subsidiary of CF&I, has become officially the **Colorado Fuel & Iron Corp., Pacific Coast Division.** Personnel and operating procedures remain the same.

ABSTRACTS

THE HEAT-TREATMENT, INSPECTION, AND TESTING OF WROUGHT NICKEL AND NICKEL ALLOYS

W. Betteridge (Mond Nickel Co Ltd), T. E. Cound (Henry Wiggin & Co Ltd). *Inst Met Journ* 1955 Vol 83 (6) pp 262-270 (Feb.)

Wire: tungsten carbide dies used for all materials from 0.375 to 0.032 in. dia; diamond dies for finer gauges. Both carbide and diamond dies periodically withdrawn for inspection and re-polishing to next larger size; former normally re-polished 6 to 8 x, latter 3 or 4 x. Avge weights of wire drawn through carbide dies before re-polishing, and target and avge weights, for diamond dies tabulated. Various wire tests described, 3 illustr, 14 ref, 3 tables.

Y* **C 11.0: D 11.0**

★ ★ ★

THE ABRASION (WEAR) OF DIAMOND DIES

L. Schultink, H. L. Spier, A. van de Wagt. *Appl Sci Res A* 1954 Vol 5 (1) pp 1-11

New theory with regard to hardness vector properties of diamond based on elementary tetrahedra. View confirmed by electron microscopic investigations after etching diamond surfaces in hydrogen furnace. From this investigation, concluded that best diamond die with regard to wear obtainable by drilling perpendicular to (111) axis. Stated, however, that theory should be tested by having series of dies made from same diamond and drilled exactly in the 3 main directions, abrasion rate being studied under same working conditions. This did not prove feasible; tests could only be made on diamonds of same geographic origin. Another form of test is by measuring abrasion rate of large number of diamond dies taken from normal production, and determining their orientation by x-ray diffraction. Stated that such investigations underway, but results not yet available. (Expansion of previous paper (Philips Techn Rev 1954 Vol 16 (3) pp 91-97). These statements are at variance with other investigations —Ed.)

G **C 2.23 : C 11.0**

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Bright, Smooth No. 3 Finish takes Plating Beautifully—Adds Eye-Appeal to Your Products

Continental's new technique for producing #3 finish flat and special shaped wire offers you a range of standard and special wire shapes with a satin smooth finish for electroplating purposes. Previously, only flat wire with a surface suitable for high polish electroplating was obtainable . . . but now from Continental you can specify #3 finish in flat, square, rectangular, oval, and other shapes on inquiry, in practically any size, temper, and analysis in low carbon and medium low carbon steels. Here is extra "eye-appeal" for moldings, product trim, or wherever a formed plated wire component is required. Send us a blueprint of your part, or mail the coupon below for complete information without obligation. Telephone or write today.

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Manufacturer's wire in many sizes, shapes, tempers and finishes, including Galvanized, KOKOTE, Flame-Sealed, Coppered, Tinned, Annealed, Liquor Finished, Bright, and special wire. ALSO, Coated and Uncoated Steel Sheets, Nails, Continental Chain Link Fence, and other products.

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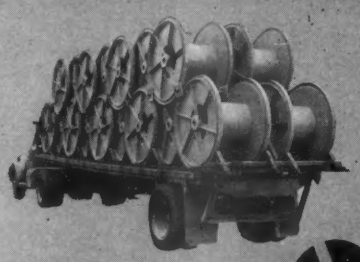

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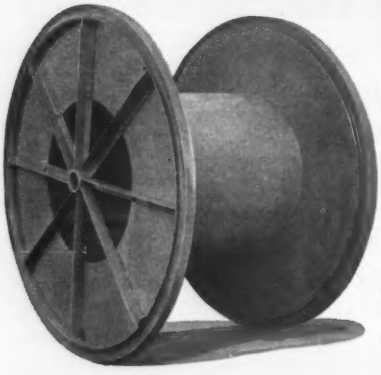

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because they cost so little more, last *12 times* longer than wooden reels, require minimum maintenance. Rugged weatherproof, splinter-proof, warp-proof construction protects costly cable against damage due to dropping, bouncing, rough handling. It doesn't pay to risk an investment of thousands on inferior reels.

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SERVICE IS OUR BUSINESS: Qualified engineering staff will translate your problems into practical designs, from idea to finished product—or we'll work from your blueprints. 2 large modern plants with every automatic production facility, 100 in skilled personnel. Fast deliveries—motor, rail, water shipping at the premises.

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These leading mills prefer NYECO Steel Reels: OKONITE, ROEBLING, WESTERN ELECTRIC, GENERAL CABLE, ANACONDA, PHELPS DODGE

AUS DER GESCHICHTE DER DRAHTFABRIKATION. THE HISTORY OF WIRE MANUFACTURE

T. Buchwald. *Draht-Welt* 1955 Vol 41 (6) pp 74-76 (Mar 25) (In German)

Short historical account. 4 ref.

G **C 11.1**

★ ★ ★

EIN BEITRAG ZUM ERMITTELN DER ABRIEBFESTIGKEIT DER SCHUTZSCHICHT ISOLIERTER DRAEHTE. THE DETERMINATION OF THE WEAR RESISTANCE OF PROTECTING LAYERS OF INSULATED WIRES

E. Franke. *Draht-Welt* 1955 Vol 41 (6) pp 69-72 (Mar 25) (In German)

Survey of various methods.

G **C 4.0 : C 11.0**

★ ★ ★

HEAT-TREATMENT AND FINISHING OPERATIONS IN THE PRODUCTION OF COPPER AND ALUMINUM ROD AND WIRE

H. J. Miller (Brit Insul Callender's Cables Ltd). *Inst Met Journ* 1955 Vol 83 (6) pp 221-232 (Feb)

8 illustr, 17 ref, 1 table.

Y* **C 11.0**

★ ★ ★

EXPERIMENTAL STRESS DETERMINATION WITHIN A METAL DURING PLASTIC FLOW

E. G. Thomsen, J. T. Lapsley jun. *Soc Exp Stress Anal Proc* 1954 Vol 11 (2) pp 59-68; abstr *Iron & Steel Inst Journ* 1955 Vol 179 (1) p 96 (Jan)

Y* **C 4.0 : C 11.0**

★ ★ ★

DRAWING PRACTICE FOR SPECIAL STEEL WIRE

A. Wilczek. *Draht* 1954 Vol 5 pp 120-123 (Apr); abstr *Iron & Steel Inst Journ* 1955 Vol 179 (1) p 92 (Jan) (Original in German)

Y* **C 11.0**

★ ★ ★

BESONDERE RECHENVORTEILE MIT DEM RECHENSCHIEBER IN DER DRAHTINDUSTRIE. SPECIAL CALCULATION ADVANTAGES OF THE SLIDE RULE IN THE WIRE INDUSTRY

Anon. *Draht-Welt* 1955 Vol 41 (7) pp 95-96 (Apr 10) (In German)

Explanation of use of slide rule for calculations in wire industry. 4 illustr.

G **C 11.0**

These abstracts are published through the courtesy and with the permission of the Industrial Diamond Research Bureau, 34 Holborn Viaduct, London, E.C.1, England. Inquiries regarding them should be directed to the Bureau.

Outstanding Personalities of the Wire Industry

Made Plant Manager of Standard Machinery

The appointment of **Roger H. Lawton** as plant manager of **The Standard Machinery Company,** Mystic, Connecticut, has been announced by the president of the firm, **John R. Wheeler.**

★ ★ ★

For the past eight years, Mr. Lawton has been associated with the Rodney Hunt Machine Company of Orange, Mass.; from 1946 to 1951 as superintendent, and since the latter date as plant manager. Prior to that, Mr. Lawton was with the Federal Shipbuilding and Dry Docking Company of Kearney, N. J., a subsidiary of U. S. Steel.

★ ★ ★

An electrical engineer, Mr. Lawton has also studied naval architecture and marine engineering, and has completed a course in management training sponsored by the American Management Association.

Roger H. Lawton

★ ★ ★

The Standard Machinery Company, for whom **Davis-Standard Sales Corporation** is the sole selling agent, specializes in the manufacture of extruders for rubber and plastics, and electrical wire insulating machinery.

Johns Becomes ACCO's Chief Executive Officer

Cyrus N. Johns, president, **American Chain & Cable Company, Inc.** was elected the company's chief executive officer at the annual meeting of ACCO stockholders in May. Mr. Johns succeeds **Wilmot F. Wheeler,** who has held this position since 1946. Mr. Wheeler will continue as chairman of the board.

★ ★ ★

Stanley Mann, who retired as treasurer after more than 40 years of service with the company, was named treasurer emeritus and will continue as a director.

★ ★ ★

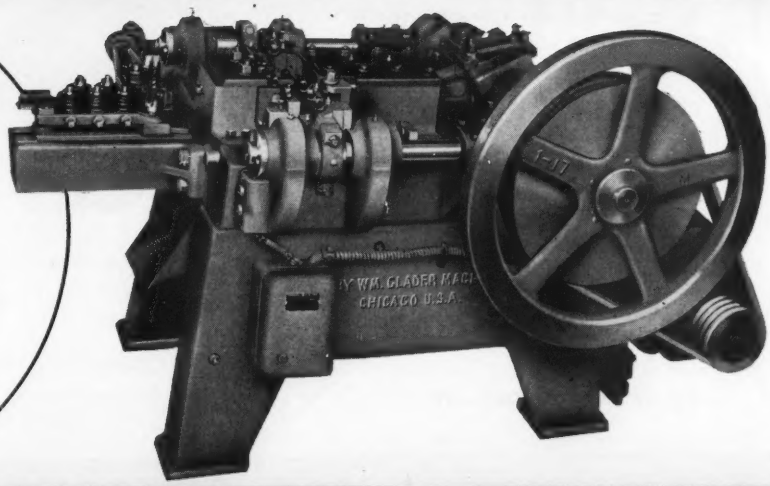
GLADER

HIGH SPEED WIRE NAIL MACHINES

HIGH TONNAGE OUTPUT—LOW MAINTENANCE COST

You can take care of increased production schedules and better product demands with these machines of established reputation.

For 55 years GLADER MACHINES have been giving HIGH QUALITY, LOW COST nail production.



Wm. Glader Machine Works 210 N. Racine Avenue Chicago 7, Illinois

Export Dept.: 122 E. 42nd Street, New York 17, N. Y.

Arthur C. Laske, secretary of the company since 1944, succeeds Mr. Mann as treasurer and continues as secretary.

★ ★ ★

Wilmot F. Wheeler, Jr., assistant to the president since 1953, was elected a vice president.

★ ★ ★

Mr. Johns joined **Page Steel & Wire Company** at Monessen, Pa. in 1916, which was later acquired by American Chain & Cable. He was appointed works manager of the Page Steel & Wire Division there in 1930, and later served as general manager of that division. In 1940, he was appointed vice president in charge of operations for all ACCO plants. He became executive vice president in 1946 and president in 1951.

Cyrus N. Johns

★ ★ ★

Mr. Johns is a director of **American Chain & Cable Company, Inc., Dominion Chain Co. Ltd., Maryland Bolt & Nut Co., Parsons Chain Co. Ltd. (England). The Bristol Company,** and **The Allison Company.**

★ ★ ★

Included among his affiliations are the American Society of Mechanical Engineers, American Iron & Steel Institute, and The Wire Association. He is a graduate of the University of Missouri, class of '16, with an M. E. degree.

ARKELL

POINTS THE WAY to
lower wire wrapping costs

...by recommending
"Arksafe" CRINKLED KRAFT WIRE WRAP

For a tighter, more compact wrap! Easy to handle, simple to apply. Uniform crepe. Strong—Economical!

CONSTRUCTION: Plain or waxed single ply kraft; asphalt or non-staining resin laminated; polyethylene coated or polyethylene laminated. Also reinforced wherever strength is needed.

Available in HAND ROLLS and in STANDARD ROLLS and WIDTHS for use on STANDARD MACHINES.

For Details write Dept. WP-1

ARKELL SAFETY BAG COMPANY
10 EAST 40th STREET (Established 1896) 6345 WEST 65th STREET
NEW YORK 16, N. Y. CHICAGO 38, ILLINOIS
Plants: Chicago, Illinois, and Newport News, Virginia

Promoted to Manager of Wire Sales

The Detroit Steel Corporation has announced the promotion of **James L. Sutherland** to the position of Manager of Sales, Wire and Wire Products. He replaces **J. M. Gillard,** who died recently.

★ ★ ★

Mr. Sutherland, who graduated from Ohio State University in 1939, joined Detroit Steel's Portsmouth organization in 1947, starting as Assistant Superintendent and later becoming Superintendent of the Rod and Wire Department Production Control. He was transferred to the General Sales Office in Detroit in 1950, where he handled sheet and strip sales, in addition to wire and wire products. He operates under **Howard V. Clark,** Vice President-Sales.

National Screw Announces Promotions

Price Berrien, general plant manager, was appointed works manager of **National Screw & Mfg. Co.,** Cleveland, Ohio. He now has charge of manufacturing and plant operation. **J. Robinson Hyde,** production manager, has been promoted to director of sales research and is succeeded by **Clayton J. Cross. Howard L. Hopkins,** chief metallurgist, at the same time was pro-

moted to chief engineer in charge of production engineering and **Albert J. Parker** was appointed chief products engineer, in charge of development and research on tools and new equipment.

Farrel-Birmingham Elects New President

Franklin Farrel III has been elected president of **Farrel-Birmingham Co.**, Ansonia, Conn., to succeed **Franklin R. Hoadley**, who retired on May 1st.

★ ★ ★

Mr. Farrel represents the fourth generation of his family to be actively associated with the company. He started in 1933 in the foundry and rose to become manager of their Ansonia and Derby plants. He has served as secretary, assistant to the president and for the last five years has been executive vice president. His former assistant, **Edward S. Coe**, has been appointed assistant to the president. At the same time **Robert M. Honegger**, general manager of the F-B plant at Buffalo, has been made a vice president.

Handy & Harman Elects Director

M. W. Townsend, Assistant to the President, was appointed a director of Handy & Harman by the Board of Directors at their meeting April 28th in New York.

★ ★ ★

Mr. Townsend joined Handy & Harman, processors of silver, gold, and platinum, in 1946; he served in the Sales Department and was Sales Manager prior to his present post.

Joins Hans C. Bick, Inc.

Hans C. Bick, Inc., chemical manufacturer in Reading, Pa., announces that **L. W. Schoelpple** has joined their organization, effective April 18. His previous experience in the chemical industry will be of value in his new association. Mr. Schoelpple will make his headquarters at the Reading plant, 401 S. 13th St.

Copperweld Appointments at Warren

Edgar W. Husemann, former assistant chief metallurgist, has been named chief metallurgist of **Copperweld Steel Co.**, Warren, O. He assumes direction of the metallurgical department and will report to the general superintendent and his staff and to the sales manager on customer problems.

★ ★ ★

William J. Buechling, former chief metallurgist, was appointed at the same time as assistant general superintendent of Copperweld.

U. S. Rubber Sales Changes

New sales assignments in the mechanical goods division, **United States Rubber Co.**, have been announced by **Purdy Miller**, manager of branch sales for the division.

★ ★ ★

Robert H. Bowman, formerly district manager at San Francisco, has been appointed to the same position in New York. He is succeeded in San Francisco by **Arthur C. Tharp**, formerly sales manager for the Milwaukee district.

Standardize on ACROPAK* Spools!

Only ½ the Weight!

YET STRONG, TOUGH, RIGID . . *LONGER LIFE*

ACROPAK Spools will help you cut wire packaging costs because they give longer service, require less maintenance and cost less to ship. They're strong. They'll take repeated shippings and still run true on the arbor. They're machined to close tolerances. You can run them at high production speeds with fewer snags, less toe-out and minimum end breakage.

THEY CUT YOUR SPOOLING COSTS

Best proof of ACROPAK superior performance are the millions of these spools now used by the biggest names in the wire industry. We've proved it to them—let us prove it to YOU.

- Light Weight
- Precision built
- Reduced cost
- Longer life
- Extra strength
- Dynamic balance
- Greater production
- Low cost reconditioning
- Less maintenance
- Attractive packaging

★ We also make a complete line of heavy-duty shop processing STEEL SPOOLS built to the same high standards of accuracy and rigidity as the famous Acropak aluminum spools.

ACROMETAL PRODUCTS INC.
Division U S Bobbin and Shuttle Co., 616 Fifth Street N., Minneapolis 1, Minn.

FOR – FINE – TINNED – WIRE

IT'S . . . "UTICA" — ALWAYS

COPPER WIRE . . .

• SILVER PLATED —
• TINNED —
• BUNCHED —
• STRANDED —
• BOBBINS

MADE TO EXACTING SPECIFICATIONS.

Our modern facilities are at your disposal and we invite your business.

UTICA WIRE CORPORATION

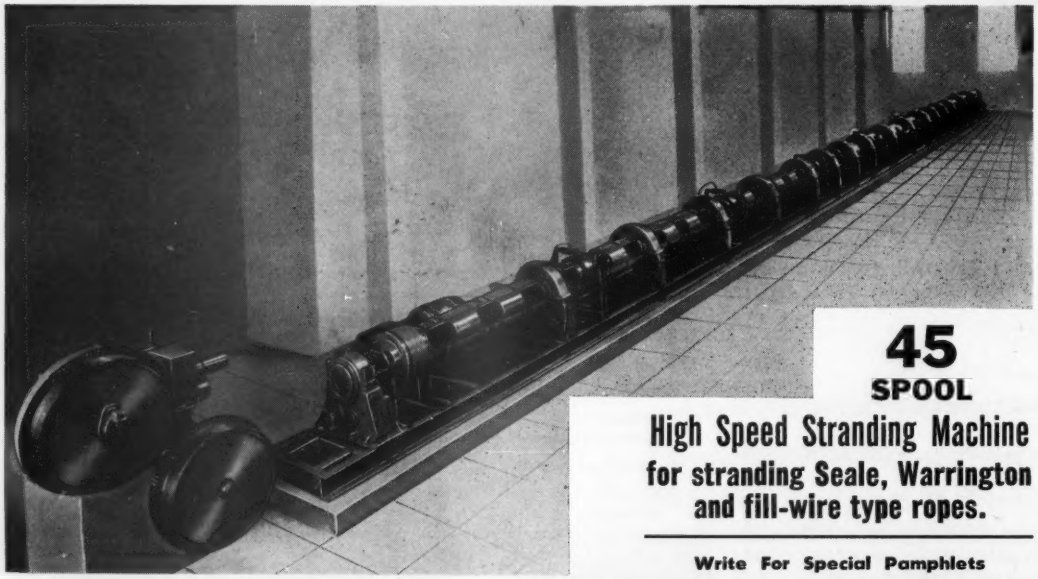
DERBY, CONNECTICUT

We specialize in **QUALITY** and **SERVICE**

NIEHAUS

WIRE STRANDING
ROPE CLOSING
CABLE MAKING

MACHINES



45
SPOOL

High Speed Stranding Machine
for stranding Seale, Warrington and fill-wire type ropes.

Write For Special Pamphlets

MASCHINENFABRIK K. A. NIEHAUS • GERMANY
DÜSSELDORF-RATH

Osmond S. True has been placed in charge of the Boston district, a transfer from his post in the same capacity in New York.

★ ★ ★

New district manager for the Denver branch is **Elmer G. Morrill,** formerly a salesman in the Houston district.

★ ★ ★

W. T. Pearl, who was a salesman in the Tulsa district, has been appointed assistant district manager in Kansas City, and **D. C. Lee,** formerly a Dallas branch salesman, has been made assistant district manager in New Orleans.

Charter Wire Adds Production Man

B. A. Miller has been appointed production control manager of **Charter Wire Inc.,** Milwaukee. He resigned as assistant purchasing agent of Ladish Co., to go with Charter.

New Line of Ovens Announced

The Carl Mayer Corporation, 3030 Euclid Ave., Cleveland 15, Ohio, has recently added a new line of portable industrial ovens for use in closely controlled production and laboratory work. These heavy-duty cabinet ovens are available with either horizontal or vertical air flow. Specially designed for temperature uniformity, the ovens are built strong for long, hard usage. They employ a high pressure motor driven blower to propel the heated air in a definite air-flow pattern through the work chamber. This prevents any disturbance due to radiant heat and assures temperature uniformity.

★ ★ ★

Some of the other outstanding features of this oven include no metal-to-metal contact, high and low heat switch for close control and quick recovery, electrical interlock for turn-off of heat in case of blower motor failure, and Inconel-sheathed "Life-time" heating elements. Partlow Indicating Temperature Control is included in the standard base price. Other control instruments are available—prices on request.

★ ★ ★

Complete details are given in Carl Mayer Corporation bulletin number 9-54.

Joins Electroplating Section of Inco

Charles B. Sanborn has joined the Electroplating Section of the Development and Research Division of **The International Nickel Company, Inc.,** in New York, according to an announcement by **O. B. J. Fraser,** Assistant Manager of the division. The Electroplating Section is principally concerned with the technical aspects of the applications and uses of nickel coatings.

★ ★ ★

Mr. Sanborn was formerly associated with Graham Crowley &

MASON lightweight, non-returnable, lithographed spools for:

INSULATED WIRE
AUTOMOTIVE CABLE
THERMO-COUPLE WIRE
TV LEAD-IN WIRE
SOLDER WIRE

IF you want dependable performance and attractive appearance—at a low, low cost—put Mason Spools at the top of your list!

Over 175 leading manufacturers can attest to the performance of Mason Spools. As for appearance... the rich, colorful perfection of Mason lithography is your best assurance of *instant brand identification.*

Mason Spools are available in 5", 6½", 8½", and 10½" head sizes. All sizes available with 1⅞" (Dia.) barrels. The 10½" head size is available with a 3½" (Dia.) barrel. Barrel lengths from ⅝" to 14".

Let us know about your spool requirements now! Telephone East Providence 1-2810 or write to the address below.

MASON CAN COMPANY
1949 Dexter Road, E. Providence 14, R. I.
Branch Plant — Greenville, Ohio

Associates, Inc., Chicago, Sherwin-Williams Company, Cleveland, and American Steel & Wire Company, Cleveland, where he was Senior Research Chemist at the company's research laboratories.

Celanese Promotes Two Men

George W. Ewald, formerly of the Development department of **Celanese Corporation of America,** has been named manager of the newly created industrial sales department of the textile division of the company. At the same time **A. S. Dempewolff,** previously manager of the market development department, was named assistant to **K. C. Loughlin,** vice president and general manager of the division.

★ ★ ★

While the market development department is being replaced, it was emphasized that its activities will be continued as a function of the industrial sales department. The new department is also engaging in special product development work in the non-woven fabric field.

★ ★ ★

Mr. Dempewolff in his new capacity will undertake studies and special projects and will assist the general manager in administration.

W. C. Collinge

***The* death of *W. C. Collinge*, Managing Director of the Paragon Wire Works, *Robert Thornton, Ltd.*, Cleckheaton, Yorks, England, is announced with regret by his former associates. Mr. Collinge passed away on May 17, 1955. Prior to his association with Robert Thornton, he had been affiliated with John Rigby & Sons, Ltd.**

Six Distributors Appointed By Firth Sterling

As part of its program to intensify coverage and improve service in key marketing areas, **Firth Sterling** has announced the appointment of six new authorized distributors for Firthite (sintered carbide) tips, blanks and tools; high speed toolholder bits; drill rod; and ground flat stock.

★ ★ ★

They are:

Christensen Machinery & Supply Company—Menominee, Michigan
Sanders & Lumberry, Inc.—Peoria, Illinois
Gary Mill Supply Company—Gary, Indiana
Tri-tex Machine & Tool Company—Houston, Texas
Southwest Industrial Sales Company—Dallas, Texas
Perine Machinery & Supply Company—Seattle & Spokane, Washington; Portland, Oregon

★ ★ ★

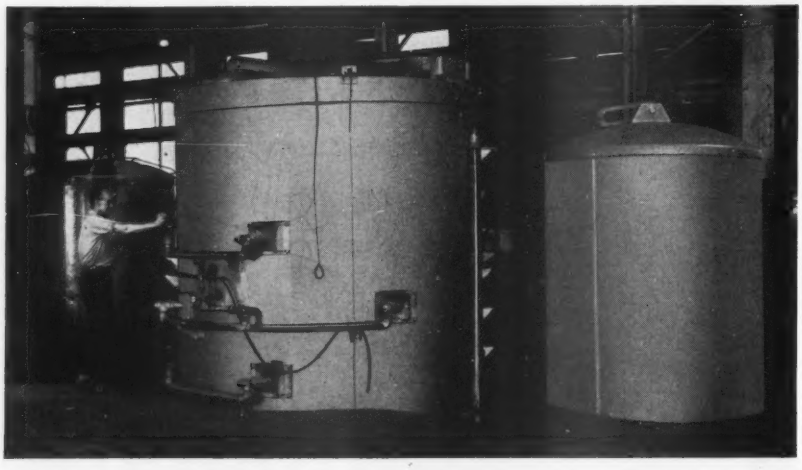
Firth Sterling markets a complete line of high speed steels, tool and die steels, and sintered tungsten carbides through a nationwide network of 10 District Offices and more than 170 authorized distributors.

Restored Steel Industry "Birthplace"

The Saugus Ironworks Restoration, the "birthplace" of America's iron and steel industry, opened its 1955 season on April 19th.

★ ★ ★

The nation's first successful ironworks, which was formally dedicated last fall, required six years of research and planning and more than $1,500,000 to reconstruct the "living" outdoor museum for visitors to see the begin-



Bright Annealing Wire Uniformly in ROCKWELL BELL FURNACES

In this Rockwell installation four furnace bases and one gas fired, bell type furnace provide the required operating flexibility of heating, loading and unloading the work. Each base is equipped with a circulating fan to distribute heat uniformly to the charge.

A steel hood is placed over the work and sealed tight. The load of copper product is bright annealed in a protective atmosphere and cooled in the hood.

Rockwell bell furnaces (cylindrical or rectangular) are built to specifications for bright annealing steel and non-ferrous wire in coils or on spools.

Write for Bulletin 432 on Rockwell Wire Mill Furnaces.

ROCKWELL ALSO BUILDS
Batch and continuous furnaces and ovens for annealing, aging, drying, enameling, tinning, glass coating, synthetic coating. Atmosphere generators.

ROCKWELL SINCE 1888 BUILT

W. S. ROCKWELL COMPANY
FURNACES • OVENS • BURNERS • VALVES • SPECIAL MACHINERY
2425 ELIOT STREET • FAIRFIELD, CONN.
Sales Representatives in Principal Cities

nings of one of America's greatest industries.

★ ★ ★

The 17th century ironworks, located ten miles north of Boston, was erected 130 years before the American Revolution and was considered the industrial wonder of its day.

★ ★ ★

Its operations and equipment, which has been restored authentically in every detail, compared with the best in use by contemporary ironworks in Europe. Its ingenious rolling and slitting mill was one of the few existing in the entire world at that time.

★ ★ ★

Key structure at the restoration is a replica of the original stone blast furnace, with its 16-foot water wheel and pair of giant leather bellows. Many of the stones in its massive walls, found while excavating the area, were once part of the original furnace.

★ ★ ★

Poised above the 300-year-old forge is a giant 505-pound iron hammerhead ready to beat out the impurities from the red-hot iron "sow" bars which were converted into usable wrought iron.

★ ★ ★

High on a bank above the ironworks is the home of the ironmaster, which is furnished with many precious antiques.

★ ★ ★

The restoration is open from 9:00 A. M. to 4:00 P. M. daily, except Mondays, through December 1st. Trained guides will explain how the works operated and answer visitors' questions.

Joins Syncro Staff as Consultant

E. J. McIlvried, Sr., who resigned recently from the Vaughn Machinery Company, where he was Vice President and Chief Engineer, has joined the staff of the Syncro Machine Company, Perth Amboy, N. J., as a consulting Engineer.

★ ★ ★

Mr. McIlvried, well and widely known throughout the wire industry, has been a member of The Wire Association for many years. The Syncro Machine Company engages in the manufacture of a wide variety of equipment—wire drawing, shaving, stranding, tinning, coiling, annealing, taping and other wire processing and handling machines.

Carl F. Mayer, Sr.

Carl F. Mayer, Sr., president and founder of the Carl Mayer Corporation, Cleveland, Ohio, passed away suddenly April 20.

★ ★ ★

He will be succeeded as president by his son **Carl Mayer, Jr.** who has been vice-president and general manager of the company since 1951. Mr. Mayer has been associated with his father in the operation of the industrial oven design firm for the past ten years.

TO SELL—ADVERTISE IN
WIRE AND WIRE PRODUCTS
It pays—send for rates
453 Main St., Stamford, Conn.

When wrapping your wire or rod

...REMEMBER

It's the **Crinkle** in the PAPER that COUNTS!

For a tighter, more compact wrap, specify—
***"Arksafe"* CRINKLED KRAFT WIRE WRAP**

Easy to handle, simple to apply. Uniform crepe—Strong and *Economical*, too!

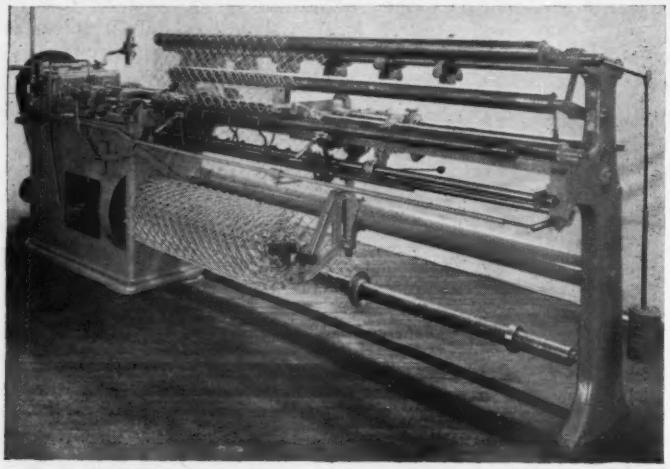
CONSTRUCTION: Single ply, waxed, asphalt laminated and reinforced.

In Standard Rolls and Widths for use on all types of wrapping machines. Also available in Hand Rolls.

For details, write Department WP-1.

ARKELL SAFETY BAG COMPANY
10 EAST 40th STREET (Established 1896) 6345 WEST 65th STREET
NEW YORK 16, N. Y. CHICAGO 38, ILLINOIS
Plants: Chicago, Illinois, and Newport News, Virginia

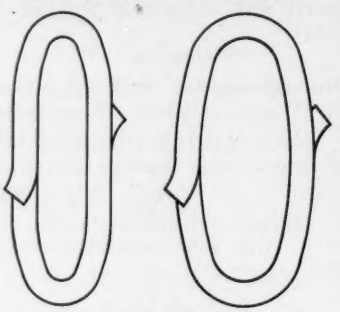
INVINCIBLE Chain-Link Fence Machines • Greatest Profit Makers in Wire Fencing!



Keeps its form best against rough usage

End view of the Spirals:

Invincible Others



In weaving the two wires there are 4—½ turns per mesh.

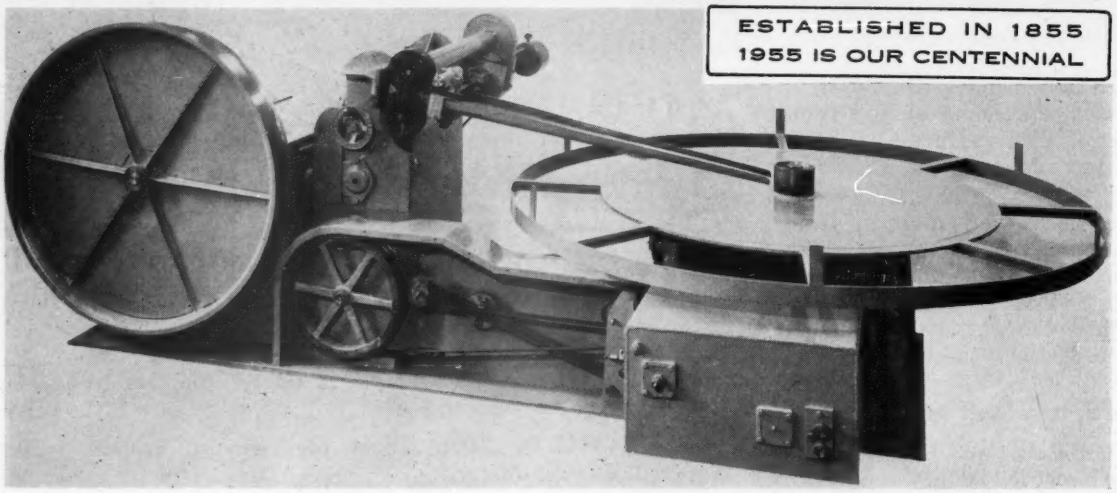
Invincible's high production cuts the wage cost. It also saves power, floor space, and WIRE. With normal care the Invincible's Modern Construction gives a long life. Our capacity in building Invincibles is as yet limited. It is the machine you will "eventually buy". It gives a real chance for an increase in profits. It will pay to get in on one quickly.

ARTHUR BLASHILL & COMPANY

Temporary Office: 78 Downing Street

WORCESTER 10, MASSACHUSETTS, U. S. A.

ESTABLISHED IN 1855
1955 IS OUR CENTENNIAL



SINGLE TABLE PANNING MACHINE NO. 1149

Arranged to Accommodate 80" Diameter Pans.
Can be Built for Larger Pans.
Cut Shows 42" Diameter Capstan.
Wire Guide Spout is Stationary.
Table with Pan Traverses. Pan Table is provided with a Lock so that Table can be released for Hand Panning.
Can be Built as Shown or Opposite Hand.
Not Shown are the Main Variable Drive and also the Guard over the Traverse and Table Drive.

EST. 1855 AIMCO INC. 1915

"American" INSULATING MACHINERY COMPANY

REG. U.S. PAT. OFF.

FAIRHILL AND HUNTINGDON STREETS

PHILADELPHIA 33 PENNSYLVANIA U.S.A.

Made Superintendent of Copper Wire Company

The Utica Wire Corporation, Derby, Conn., has announced the appointment of **George Roth** as superintendent of its plant, placing him in complete charge of the mill.

★ ★ ★

Mr. Roth has had 20 years of experience in all phases of the wire business and has assisted in the work of completely revamping the recently enlarged mill to tighten on quality control and expedite orders for the plant's growing list of customers.

★ ★ ★

Utica specializes in fine tinned wire, which is supplied bare, bunched, stranded or on bobbins for sheathing cable. The recent enlargement was in the bunching and stranding department.

A Hand Machine That Speeds Up The Tool Makers Work

Fully described and illustrated in a new brochure, this tool is known as the Di-Profiler. It is a power hand tool that mechanically scrapes, hones, mills, files, polishes, saws, laps, grinds and engraves dies and tools with a minimum of effort. It is claimed that it operates 50 to 100 times faster than other hand means.

★ ★ ★

The folder illustrates more than a dozen different applications of this handy precision tool and illustrates also the numerous accessories that make a tool and die makers job easier. With this complete die filing equipment, as provided by **Nord International Corp.,** any tool maker can accomplish the work required of him to make many special tools and he can do it at least 50 times faster because the "elbow grease" factor has been eliminated.

★ ★ ★

Write to Nord International Corp., 449-W Central Ave., Orange, N. J.

TO SELL—ADVERTISE IN
WIRE AND WIRE PRODUCTS
It pays—send for rates.
453 Main St. Stamford, Conn.

Ground Broken by Atlantic Steel for Rod and Bar Mill

Atlantic Steel Company broke ground for its new $8½ million merchant bar and rod mill on May 17th.

★ ★ ★

According to **R. S. Lynch,** president, the new mill is the first phase of a modernization and improvement program and will substantially increase the company's productive capacity and product range.

★ ★ ★

The new Morgan mill will be housed in a building 740 feet long by 100 feet wide. Two warehouses attached to the main building will occupy an additional 52,000 square feet of space. The mill is expected to be completed and in operation by September, 1956.

★ ★ ★

Mr. Lynch said this construc-

Refinishing Wire Drawing Dies?

Save Money with NORBIDE® Abrasive . . .

Second in hardness only to diamond which costs a hundred times more

Johnson Steel & Wire Co., Inc. has substantially reduced the cost of refinishing their wire drawing dies by substituting NORBIDE Abrasive for costly diamond dust. Excellent for ripping or for fast stock removal as well as for accurate semi-finishing operations.

High accuracy is important to Johnson for Johnson "music" spring wire is drawn in 200 different sizes, all the way from .003" to .200".

If you are still using diamond dust for your ripping and semi-finishing operations, you'll be amazed at the savings you can obtain by switching to NORBIDE Abrasive.

For cost-cutting abrasive details, write for Form 559.

NORTON COMPANY
45 New Bond Street • Worcester 6, Massachusetts

NORTON
BORON CARBIDE

NORBIDE® . . . the hardest man-made abrasive

tion program is designed to keep Atlantic Steel in step with the growing demand for steel products in the Southeast.

Metalurgia General

Published in March, 1955, in 2 volumes, this book was written by **Prof. E. Jimeno,** Director, Metallurgical Laboratories, University of Madrid, and **Dr. F. R. Morral,** Head, X-Ray Laboratories, Kaiser Aluminum & Chemical Corp., Spokane, Wash. It is distributed by Aguilar, Madrid, Spain, and sells for 375 pesetas. It contains 1,323 pages of material.

★ ★ ★

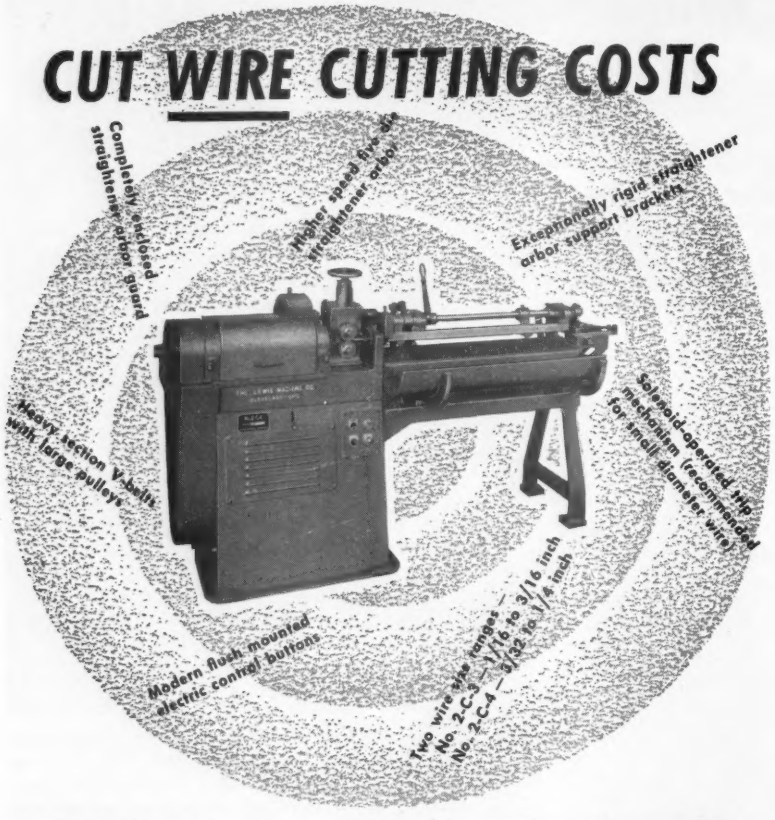
The work is written in Spanish and covers the extractive, physical, mechanical and chemical aspects of general metallurgical matters. While written primarily for the training of scientists, engineers and technicians in Spanish-speaking countries, it is also of value to the consultant as a reference book.

★ ★ ★

Its 37 chapters are profusely illustrated with line drawings, photographs and tables. Subjects covered are the extraction of metals from ores, crystal structures, alloys, casting, cutting, analysis and testing, X-Ray analysis, welding, applications of metals, corrosion and other phases of metallurgy. The book is completely indexed.

★ ★ ★

Dr. Morral is a member of The Wire Association.


CUT WIRE CUTTING COSTS
Completely enclosed straightener arbor guard
Higher speed five-die straightener arbor
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Heavy section V-belts with large pulleys
Solenoid-operated trip mechanism (recommended for small diameter wires)
Modern flush-mounted electric control buttons
Two wire size ranges — No. 2-C-3 — 1/16 to 3/16 inch
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with LEWIS 2-C wire straightening and cutting machines

Only **LEWIS 2-C-3** and **2-C-4** wire straightening and cutting machines have **all** of these features for fast, accurate and economical production. Their practical design and sturdy construction, reflecting more than 40 years' experience in manufacturing wire machines for **every** production requirement, assure uninterrupted service and maximum production at minimum cost. Write, wire or call today for additional information on LEWIS 2-C wire straightening and cutting machines.

Literature is available on the COMPLETE Lewis line of 23 machines for wire from .012" and stock to 3/4".

THE LEWIS MACHINE CO.

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New Price List Issued by Scovill Covers Aluminum Mill Products

A new Price List, No. 2-5, effective May 25, 1955, has been issued by **Scovill Manufacturing Co.,** 99 Mill St., Waterbury 20, Conn., covering aluminum rod mill products. Copies are available by writing the company.

Spencer Wire Promotes Weber

Clifford G. Weber was unanimously elected on April 26, 1955 to the office of Assistant Vice-President of **Spencer Wire Corporation,** Union, New Jersey.

New Carbide Grade Chart Published

Firth-Loach Metals, Inc., P.O. Box 486, McKeesport, Pa., has published a chart of carbide manufacturers' grade recommendations, giving carbide industry classifications of the different grades, the manufacturers' designations, the applications and other data. On the reverse is another grade selection chart devoted only to their grades of Firlomet. This covers the full line, with recommended uses following each grade.

Wire Company Moves to Peekskill

The Stamford Processing Company, producers of copper wire for electrical conductors, has announced its removal to a new plant located at 10-24 So. Water St., Peekskill, N. Y. The company previously had its plant in Stamford, Conn.

A Review of Recent Wire Patents

The data listed below is only a brief review of recent patents pertinent to the readers and subscribers of this publication.

Complete copies of these patents may be obtained by writing to the publisher of this magazine and remitting 50¢ for each copy desired. For orders received from outside the United States the cost will be $1.00 per copy.

No. 2,707,693, PROCESS FOR PRODUCING ELECTRICAL COILS, patented May 3, 1955 by Stanley O. Dorst, North Adams, Mass., assignor to Sprague Electrical Company, North Adams, Mass., a corporation of Massachusetts.

A process for producing electrical coils is disclosed which comprises passing at least one conductor wire insulated with an integral coating of finely divided particles of ceramic material through a suspension of particles of a polymer of a tetrahaloethylene, removing the suspending medium from the coating of the polymer thus left on the wire, winding the wire into the form of an electrical coil and heating the coil under pressure at a temperature sufficient to fuse said polymer particles together.

★ ★ ★

No. 2,707,703, HEAT STABLE, INSULATED, ELECTRICAL CONDUCTORS AND PROCESS FOR PRODUCING SAME, patented May 3, 1955 by Stanley O. Dorst, North Adams, Mass., assignor to Sprague Electric Company, North Adams, Mass., a corporation of Massachusetts.

This is a process for coating a flexible electrical conductor wire, which process comprises electrophoretically applying to wire a coating of refractory particles and of particles of a resin of polymers or copolymers of tetrafluoroethylene, and then fusing the resin particles together.

★ ★ ★

No. 2,708,024, WIRE DRAWING APPARATUS, patented May 10, 1955 by George Bryden, Elmwood, Retford, England, assignor to Marshall Richards Machine Company Limited, Crook, England, a British company.

A multiple die wire drawing machine is disclosed comprising a number of dies and pulling blocks alternately arranged so that the wire passes directly from a die to its pulling block and thence to the next die, separate direct current electrical motors for driving each block, the motors being constructed so that their field strengths are independent of their armature currents and being connected with their armatures in series and their fields in parallel with a power supply, rheostats connected to each motor field circuit for varying the individual field strengths of the motors relative to each other, and means for increasing or decreasing the speeds of all motors simultaneously.

★ ★ ★

No. 2,708,173, ELECTRICAL CONDUCTOR HAVING INSULATION CONTAINING A POLYVINYL CHLORIDE RESIN AND A PENTAERYTHRITOL DIBUTYRATE DICAPRYLATE PLASTICIZER, patented May 10, 1955 by Milton S. Greenhalgh, Bridgeport, and Stanton C. Martens, New Haven, Conn., assignors to General Electric Company, a corporation of New York.

Intended for use at 90°C. and having improved insulation resistance in wet locations at 60°C. this conductor comprises (1) a metallic core and (2) insulation for the latter comprising (a) a solid vinyl chloride resin selected from the class consisting of polyvinyl chloride and copolymers of vinyl chloride and vinyl acetate and (b) a plasticizer for the vinyl chloride resin comprising pentaerythritol dibutyrate dicaprylate having a per cent hydroxyl within the range of from about 0.1 to 0.5 per cent, this plasticizer comprising, by weight, from 30 to 70 per cent of the weight of the vinyl chloride resin.

★ ★ ★

No. 2,708,215, JACKETING MATERIAL FOR HIGH FREQUENCY CABLES, patented May 10, 1955 by Solomon Kaganoff, Bloomfield, N.J., assignor to International Telephone and Telegraph Corporation, a corporation of Maryland.

The invention resides in the provision, about the wire conductor of a jacket of polyethylene dielectric, then braid, and a non-contaminating polyester-plasticizer outer lamination, obtained by reacting together 1,3-butanediol and sebacic acid to a reaction stage to give a polyester liquid reaction product having a refrac-

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tive index "D 25", C. in the range from 1.4686 to 1.4696, this lamination having a standard brittle point temperature of at least-40°C. and being non-contaminating to polyethylene.

★ ★ ★

No. 2,708,445, WIRE PROCESSING APPARATUS, patented May 17, 1955, by Walter J. Manson and Herbert Kenmore, Jersey City, N.J., assignors by mesne assignments, to National-Standard Company, a corporation of Michigan.

This apparatus is adapted to handle heavy wire for processing in a series of baths below a horizontal roller upon which the turns of wire are advanced.

★ ★ ★

No. 2,708,454, WIRE SPREADER FOR USE IN WEAVING A DIAMOND MESH WIRE PANEL, patented May 17, 1955 by Marshall J. Crouch, San Francisco, Calif.

Included is a device for springing the free end portions engaged by said elements away from the free end portion of alternate parallel lengths of partially woven wire between the other alternate lengths to facilitate the insertion of a wire to a position between the first and second alternate lengths.

★ ★ ★

No. 2,708,460, PRODUCTION OF SPRING PAD STRUCTURES, patented May 17, 1955 by Lawrence De Frances, Bronx, N.Y., assignor to Zeidler Manufacturing Company, Inc., White Plains, N.Y., a corporation of New York.

There are nine claims to this patent for a method of producing a long coil strip of a spring support structure.

★ ★ ★

No. 2,708,461, APPARATUS FOR ASSEMBLING COIL SPRING UNITS, patented May 17, 1955 by John R. Greeno and Thomas J. Dull, Cincinnati, Ohio, assignors to John R. Greeno Co., Cincinnati, Ohio, a corporation of Ohio.

More specifically the invention resides in the provision of a spring-receiving section for a machine for assembling rows of coil springs each consisting of an individual spiral coil wire having respective terminal coils at its upper and lower ends.

★ ★ ★

No. 2,709,140, INSULATED ELECTRICAL CONDUCTOR, patented May 24, 1955 by John C. Michalek, Niagara Falls, N.Y., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia.

The wire conductor is insulated with a dielectric composition comprising a polymer of 2,5-dichorostyrene.

★ ★ ★

No. 2,709,553, METHOD OF WIRE COILING, patented May 31, 1955 by Hubert E. Wellcome, Fairfield, Conn., assignor to Florence K. Wellcome, Pleasantville, N.Y.

The method is disclosed of making a coil of wire adapted to deliver the wire by withdrawal therefrom at high delivery speed without rotation of the delivered wire relative to the coil and without development of torsional stress in the deliyered wire.

★ ★ ★

No. 2,709,666, METHOD OF LOCALLY REMOVING THE INSULATION LAYER OF ENAMELLED WIRE, patented May 31, 1955 by Bernardus Willebrordus Speekman, Venio, Netherlands, assignor to Hartford National Bank and Trust Company, Hartford, Conn., as trustee.

A method of locally removing the insulating layer of wire enamelled by means of a synthetic enamel-lacquer is covered comprising the steps of immersing the wire in a bath of an aromatic sulphonic acid, heating the insulating layer to a temperature of at least 200°C. in order to form a carbonized layer on the wire, and wiping off the carbonized layer, thus leaving the exposed metal surface of the wire.

New Electric Wire Developed

After three years of research, a new type general purpose wire designed to withstand a wide range of temperature extremes has been perfected by engineers of **The Electric Auto - Lite Company,** Toledo 1, Ohio.

★ ★ ★

Designed specifically for modern

CAMDEN WIRE CO., INC.

Wire Fabricators

Producers of Quality Fine Wire Copper Conductors

EXTRA FLEXIBLE CONDUCTOR STRANDED OR BRAIDED

MULTIPLE ENDS OF SIZES .008 to .002

BARE • TIN or LEAD COATED • SILVER PLATED

Special Heavy Tinned Conductors for Hook-up Wire

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jet aircraft, this wire has many other applications, including electronics, industrial control circuits and heating appliances. Compared with the cost of types of high temperature wires now available, it will reduce overall production costs to manufacturers.

★ ★ ★

The wire, Auto-Lite type 350, is available in gauges from 22 through eight. It has received government approval for Mil-W-8777 U.S.A.F.

★ ★ ★

Principal advantage of the wire is that it will operate satisfactorily at temperatures ranging from minus 80° to plus 400°. Other features are:

1. **Resistance to solvents, lubricants and fuels.**
2. **Adaptability to surface marking machines.**
3. **Flexibility at low temperatures.**
4. **Resistance to fungi.**
5. **Smokelessness.**

★ ★ ★

Complete information on the wire may be obtained by writing The Electric Auto-Lite Company, Wire & Cable Division, Port Huron, Michigan.

Product Development Department Created by National Lock Washer

Gilbert E. Webster, President of **The National Lock Washer Co.,** Newark, N. J., recently announced the creation of a new department to develop new products and intensify the company's program of expansion.

★ ★ ★

Mr. Webster said their sixty-nine years of constant service to the railroad industry would be an influencing factor in the possible consideration of the addition of another railroad specialty. The company's present versatility is demonstrated in the manufacture and sale of Retaining Rings and Spring Washers, not only to the railroads but also to large industrial users. Their Precision Shaped Wire Division presently supplies the wire forming industry as well as the tool and hardware manufacturers. In addition, Hardwick, Hindle, Inc., a subsidiary, has established itself as a "Quality Name" in the Resistor and Rheostat fields.

★ ★ ★

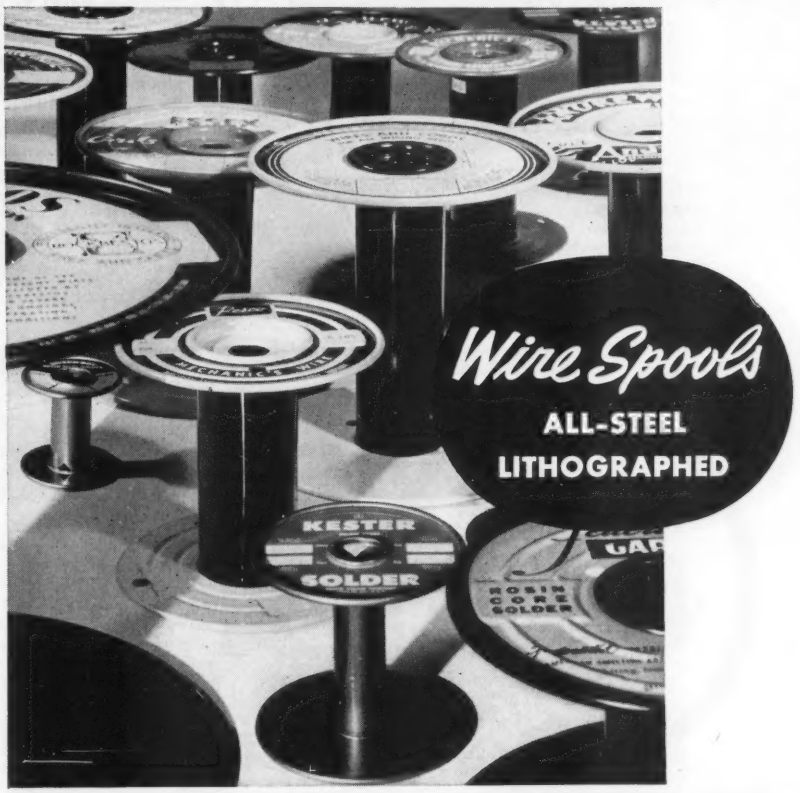
J. A. Liddell, formerly sales representative of The National Lock Washer Company in the New England area, has been appointed New Products Manager to head the new department.

New Features Added to Redesigned Straightener and Cutter

Electrically controlled clutch and target feature the redesigned Model 3A SHUSTER Wire Straightening and Cutoff Machine, manufactured by **Mettler Machine Tool, Inc.,** New Haven, Conn.

★ ★ ★

Operation of the machine may be controlled from one point, and production is substantially increased, while waste is held to a minimum. Other features of the 3A include instantaneous clutch and cutoff cam; lightning cutoff knife; V-belt motor drive; gear driven feed rolls and lower breaking rolls; and 5-Die straightening flier.



Ends and traverses may be shipped separately and assembled easily in your plant on a hand, foot, or power press.
5″ and 6-1/2″ diameter ends with 1-15/16″ diameter traverses.
10-1/2″ diameter ends with 3-1/2″ diameter traverses.
Traverse lengths up to 12″

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Important DIFFERENCES

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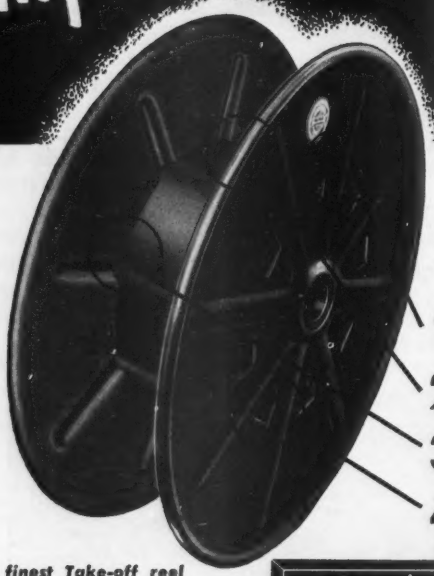

TAKE-OFF REELS

Three important differences that mean longer reel life in both processing and handling of all types of insulated wires in your plant.

1. New MPS **deep wide, straight type embossed radial rib** adds considerable strength to reel heads over the old style narrow tapered rib.
2. **Increased height of the curled edge** adds even more strength and rigidity, especially to the rims.
3. Furnished with **rib fillers** that are projections on the end of the barrels that fit into the embossed radial ribs thereby **eliminating any marking of the plastic or rubber insulated wires** at the junction of head-barrel.
4. Finally, the **all welded "J" type construction** of the entire reel completes the picture.

The finest Take-off reel you can buy.
We invite your inquiries — let us tell you more about MPS Take-off Reels. Write us today.

Mossberg PRESSED STEEL Corporation

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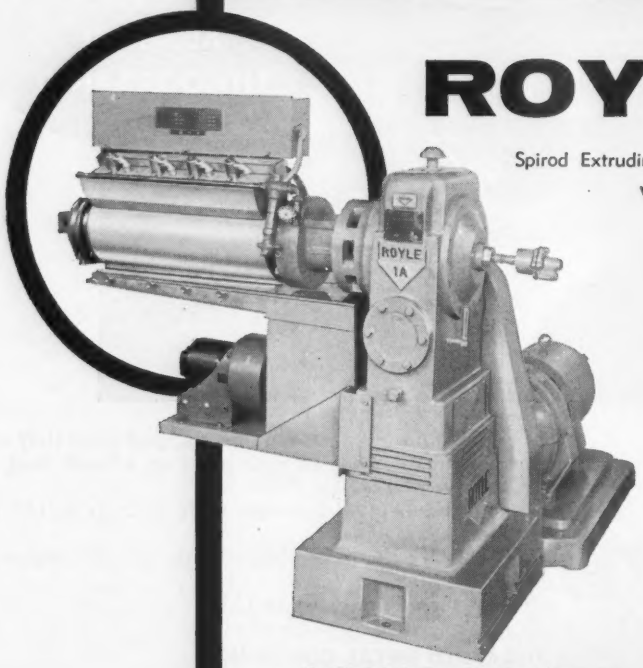
***Telephone* Attleboro 1-0848**

#109

ROYLE

1A (2½" cylinder bore)



Spirod Extruding Machine with electric heating and high velocity evaporative cooling. An all-purpose extruding machine for processing rubber and plastics.
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Strainers, Cooling Troughs, Light Wire and Cable Capstans, Motorized Take-ups, Temperature Control Units.

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Some Bending Characteristics of Cartridge Brass, 70%, and Yellow Brass, 65%, Wire

(*Continued from page 766*)

(1) In wire form, Cartridge Brass, 70%, has superior bending characteristics as compared to Yellow Brass, 65%.

(2) For Cartridge Brass, 70%, grain sizes in the order of 0.050mm. nominal appear to possess the best bending characteristics. Several exceptions may be noted in the data presented and it is believed that these variations are a function of the rate of bend as a variable, although in conducting these tests an attempt was made to perform all tests at the same rate of bend.

(3) For the temper ranges studied, Yellow Brass, 65%, appears to have its best bending characteristics in the 0.035mm. "ready" grain size range. The variance in this respect with Cartridge Brass, 70%, may be a function of the difference in the strain hardening characteristics between these alloys.

(4) Comments (2) and (3) above are made considering fracture only as the criterion of bend quality. Bend quality or lack of roughness or "orange-peel", has been disregarded although in commercial practice it would be given serious consideration.

(5) The set or "spring-back" values are presented as a guide for tool designers and no interpretation is offered.

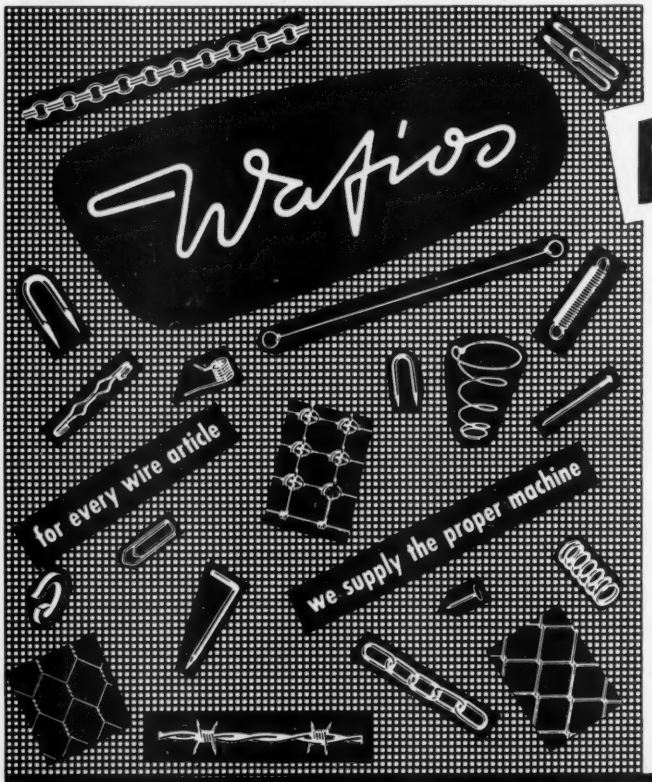
TABLE # 10

Finish Wire Size - .064" - drawn from .160" - 8# Hard (84% red.)

Sample Number	Alloy	Grain Size (ready)	Tensile
49	65/35	.015 mm	127,500 psi
50	65/35	.030 mm	126,000 psi
51	65/35	.060 mm	124,400 psi
52	70/30	.015 mm	128,500 psi
53	70/30	.035 mm	128,000 psi
54	70/30	.060 mm	126,000 psi

Upper values denote bending radius equal to 1/2 wire diameter.
Lower values denote bending radius equal to .000".

Sample Number	30° Bend	60° Bend	90° Bend	120° Bend	150° Bend
49	OK - 4° set	OK - 5° set	Fracture	Fracture	Fracture
	OK - 5° set	OK - 6° set	Fracture	Fracture	Fracture
50	OK - 5° set	OK -5° set	Fracture	Fracture	Fracture
	OK - 6° set	OK - 7° set	Fracture	Fracture	Fracture
51	OK - 5° set	Fracture	Fracture	Fracture	Fracture
	OK - 8° set	Fracture	Fracture	Fracture	Fracture
52	OK - 5° set	OK - 5° set	Fracture	Fracture	Fracture
	OK - 8° set	OK - 4° set	Fractureq	Fracture	Fracture
53	OK - 5° set	OK - 5° set	OK - 8° set	Fracture	Fracture
	OK - 7° set	OK - 4° set	Fracture	Fracture	Fracture
54	OK - 4° set	OK - 3° set	OK - 7° set	Fracture	Fracture
	OK - 5° set	OK - 5° set	Fracture	Fracture	Fracture



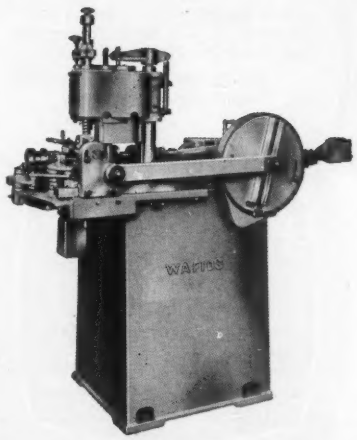
AUTOMATICS

FOR THE WIRE TRADE

AUTOMATIC TORSION SPRING COILING MACHINE

Model SFM, 4 different sizes

Wire Range: .008—.315"



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BORAX 5 MOL offers worthwhile advantages over regular borax as a satisfactory coating material on ferrous rods and wire in preparation for dry drawing. This newer material offers a higher concentration of sodium borate and therefore savings may be realized through reduced transportation, handling, and storage costs. Only about three-fourths as much Borax 5 Mol need be used to equal regular borax... yet you get the same worthwhile results!

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MANUFACTURERS OF FAMOUS "20 MULE TEAM" PACKAGE PRODUCTS

(6) It is believed that the tabulations of data offer a possible concise and rapid means of determining the maximum suitable temper for the majority of formed wire parts, when using wire in the order of 0.064" diameter.

(7) The mechanical properties reported offer a check study of the effect of grain size and percentage reduction on the ultimate tensile strength for commercially produced wire, for the alloys studied.

(8) It must be remembered that the test data presented covers bending without lubrication and it has been established that lubrication will increase the bending characteristics. In using the tables offered, this factor should be considered as a variable.

★ ★ ★

In conclusion, the authors wish to express their thanks to the **Bristol Brass Corporation** for permission to publish this paper and to **Mr. David Abbott** for his assistance with various phases of the investigation.

"Kel-F" Plastic for the Wire and Cable Industry

(*Continued from page 775*)

Summary

It was not surprising that some of the initial work that was done on "KEL-F" coated wire was not of high quality. As a result of some of the poor quality material that was produced, we feel that certain potential users of "KEL-F" coated wire have not changed their thinking. We would encourage these people to reconsider the use of "KEL-F" coated wire for their applications.

★ ★ ★

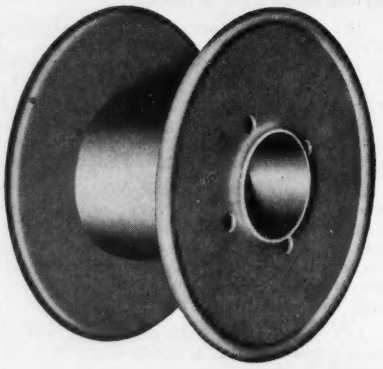
It is rare that in a single material, one can find such a great number of outstanding properties such as excellent electrical properties, extreme corrosion resistance, zero moisture absorption, abrasion resistance and high and low temperature resistance, non flammability, clarity, high strength and fungus resistance.

★ ★ ★

We feel that "KEL-F" is inherently a 190-200°C. (374-392°F.) wire. Our development and research work will be continued and actively pursued to reach this goal.

Best for today's

HIGH SPEEDS



Industry's tireless search for greater efficiency is constantly posing new problems in high speed for the wire industry. This has underscored, as never before, the need for correct design and careful construction of reels for wire drawing machines.

For over a half century, Apco Mossberg has produced reels of highest quality. Apco Mossberg High Speed Reels are manufactured to extremely close tolerances — with particular emphasis on trueness and balance.

Here's something else. It's standard practice at Apco Mossberg to give each and every inquiry about steel reels, spools or bobbins individual attention. Bring your next problem to Apco Mossberg. Without obligation, an Apco trained engineer will be glad to offer suggestions and solutions to your particular problems. Write for further details.

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The original Frank Mossberg Company

APCO MOSSBERG COMPANY

ATTLEBORO, MASS.

Wire Insulated with "Teflon" Tetrafluoroethylene Resin for High Temperature Uses

(*Continued from page* 780)

uses for wire wrapped with a tape of "Teflon". These tapes are available in thicknesses of 0.25 to 60 mils and are prepared in several ways illustrating the processing versatility of "Teflon": by casting a thin film, by molding a cylinder and skiving the tape, by extrusion of powder, by calendering molding powder, or by coating glass fabric. Accompanying this wide selection of tapes is also a broad range of properties. Consequently, the design engineer may select the type or combination of types to fulfill the particular requirements for his application and at the same time be assured of a competitive wrapping.

★ ★ ★

For example, in ignition wire for jet aircraft, military planes, and overseas commercial aircraft, adequate dielectric strength, high service temperature, cut-through resistance, and oil and gasoline resistance are mandatory. A combination of skived tape and supported tape will meet these requirements. In the petroleum industry, the high voltage leads to large electrodes require both chemical resistance and excellent dielectric properties. Several layers of skived tape of "Teflon" alone may satisfy these needs. In some hook-up wire applications, moisture resistance is vital. Therefore, a fusible form of extruded tape of "Teflon" is chosen so that moisture cannot creep in between layers of insulation.

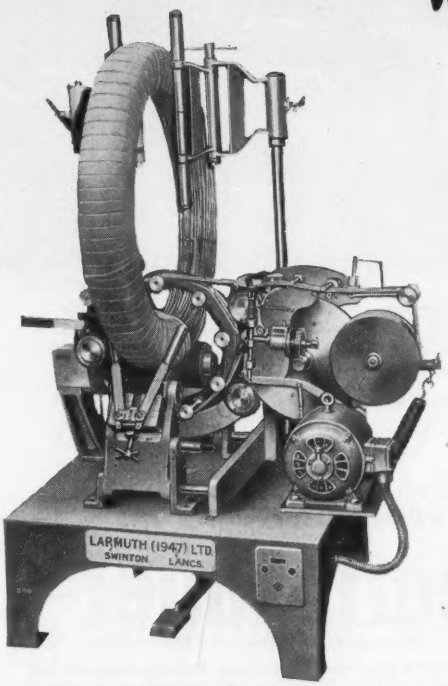
★ ★ ★

Other examples of wire using a taped construction are thermocouple wiring, oven wiring, and general lead wire for electrical testing laboratories.

Conclusion

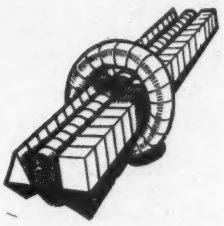
To summarize, "Teflon" has progressed significantly in its applicability as wire insulation for several reasons. First, its electrical properties are unexcelled. Second, it has a combination of properties including extremely high service temperature which makes it a lead-

LARMUTH *Spiral Wrapping* MACHINES



are built to finest British engineering standards and are in use throughout the world for spiral wrapping of Motor Tyres, coils of Wire, Strip, etc., from 3" bore upwards. Also straight length Tubes, Bars, Rods, etc.

"BOUND" to get there safely.



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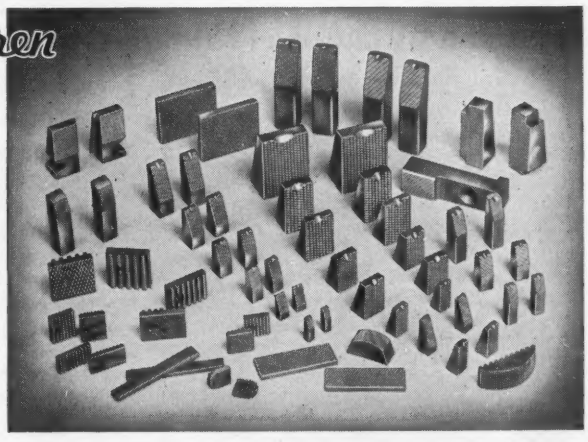

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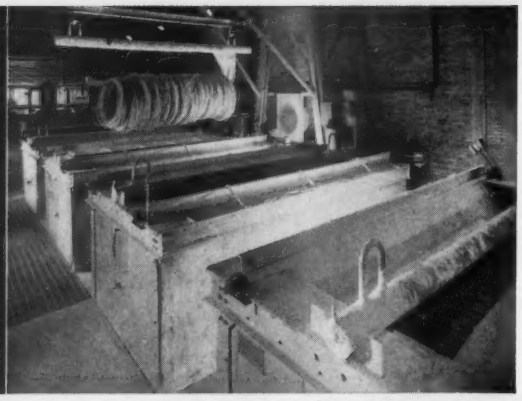
HI-SPEED REGISTERED
ROD BAKERS



Faster baking, greater fuel economy, maximum production efficiency are just a few of the results of the exclusive heating arrangement of the Carl Mayer Hi-Speed Rod Baker. It also has a patented blow-off feature which removes moisture without damage to coils.

Here are just a few of our many satisfied customers:

American Steel & Wire Co.
Atlas Steel Co.
Colorado Fuel & Iron Corp.
Crucible Steel Co. of America
B. Greening Wire Co., Ltd.
Indiana Steel & Wire Co.
Jones & Laughlin Steel Corp.
Republic Steel Corp.

Write for Bulletin No. 350

Patent Nos.
U. S. A. 2,296,361
2,323,828
2,235,559
Canada 396,144
401,589

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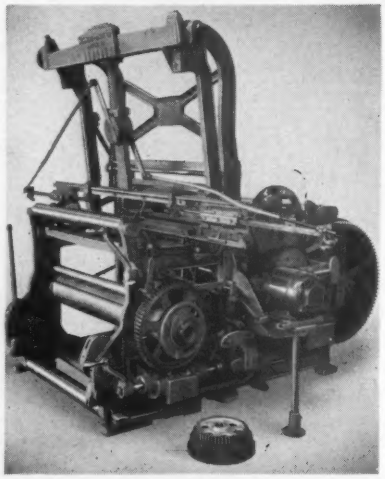
3030 EUCLID AVE., CLEVELAND 15, OHIO
OTHER PRODUCTS: Core Ovens • Mold Ovens • Welding Rod Ovens • Heat Treating Ovens & Furnaces • Special Processing Equipment and Accessories.

NEW MODERN FLY SCREEN WIRE LOOMS
Four Sizes: 36", 48", 60" and 72" Widths



TYPE No. 239
Made in 36" and 48" widths:
Shown at the left.

TYPE No. 239-360
Made in 60" and 72" widths:

These larger looms have stronger frames and heavier construction throughout.

The take-up and screen tension of the 60" and 72" widths, is effected through a ratchet, instead of the usual worm gear and weight arrangement.

Speed changes of the loom are made by changing different sizes of the motor drive pinions.

On the 48" width and wider, extension slides are provided to support and guide the longer shuttle bars.

Steel shell warp drums are used.

All looms are provided with an electric stop, which instantly stops the machine when either a warp or a cross wire breaks. All looms are motor driven.

write for details on this or other type looms you may need
We make four heavier types.

MUMMERT-DIXON CO.
HANOVER 3, PENNSYLVANIA

ing candidate for many specialty applications. Finally, improved and commercially feasible fabricating techniques have been developed so that "Teflon" now is competitive in many end uses from which it previously was restricted.

★ ★ ★

It is our objective, in presenting this paper, to assist wire design engineers and end users to obtain a fuller understanding of the product and processing properties of this unique dielectric material. We are sure that "Teflon" offers them an attractive means for solving many of their present and future wire problems.

Properties and Uses of Pure Molybdenum Disulfide As A Lubricant

(*Continued from page* 786)

pure MoS_2 powder of small particle size (maximum 64 microns) was added in varying percentages to drawing soaps or liquids; for example:

.2% MoS_2 by volume to rape-seed oil for drawing the ISOTAN wire.

2% MoS_2 by weight to a drawbox slurry of oil and lime soap for drawing coarse steel wire.

3% MoS_2 by weight to a solid soap and stearate mixture for drawing spring wire.

★ ★ ★

New developments in MoS_2 lubricant production point to an increased use in the wire industry because grades of extremely fine particle size averaging less than 1 micron are now commercially available in the powder form as well as in liquid dispersions. These finer particle size materials cover per unit weight substantially larger surface areas and are more effective and economical provided that they are pure.

★ ★ ★

It should be noted that Molybdenum Disulfide cannot be removed readily by all commercial cleaners, so that where subsequent plating is contemplated, special cleaners available for this purpose must be used.

(*Continued from page* 791)

15. DROSS IN THE COATING:—Dross in the coating may be caused by the pails going down into the drose, by carrying the dross too high, by the design of the kettle and by overheating the metal. This feature was very pronounced on the companies noted in the chart, or tables. It is seen to the best advantage on the outside just below the rim of the pail.

★ ★ ★

16. BLACK SPOTS:—As a general thing there were very few black spots on the pails. A few odd pails had them, but there were not enough present to be of any consequence.

★ ★ ★

17. WHITE SPOTS:—White spots were very prominent on some of the pails. This feature is usually caused by too high a bath temperature, but other features that also contribute to them are hard steel, inferior quality steel, poor zinc, too light a gage material for the bath temperature and too long a submersion time for the metal temperature.

★ ★ ★

18. SCUM IN THE COATING:—Some of the pails were considerably marred by scum in the coating. Scum in the coating is caused by improper skimming, a dirty metal surface, too much aluminum and poor technique of withdrawal.

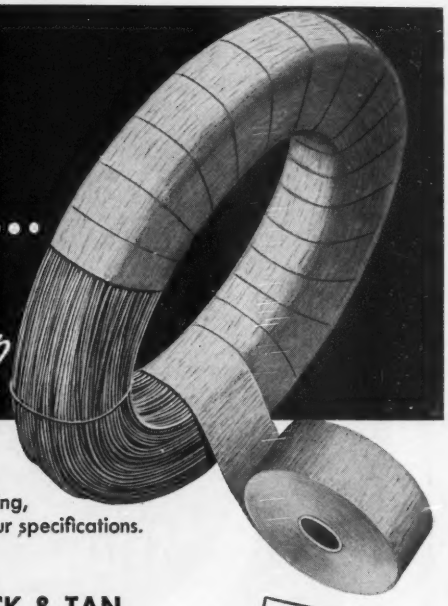
★ ★ ★

19. ZINC POINTS:—This defect was prominent on some pails. It is the sharp zinc points that are left when the metal drips and chills from the ears, rim or bottom of the pail. In handling pails, hands may become torn and badly scratched from this defect.

★ ★ ★

20. WHITE CLOUDED COATING:—This defect might in some cases be termed tarnish, but was very prominent on a few sets of pails when received by the writer. It may be caused by the acid fumes from the pickles coming in contact

for TIGHTER ALL-ROUND PROTECTION... use NATCO Spiral Wrap



Strong, with a built-in stretch, NATCO's contour-hugging spiral wrap is superior for wire coils, tubing, metal rods and bars. Made to your specifications.

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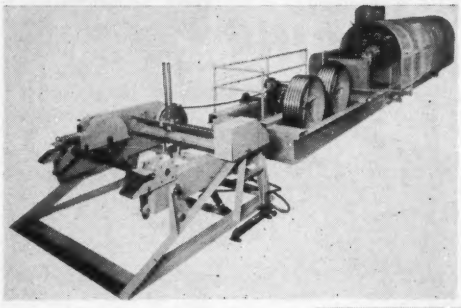
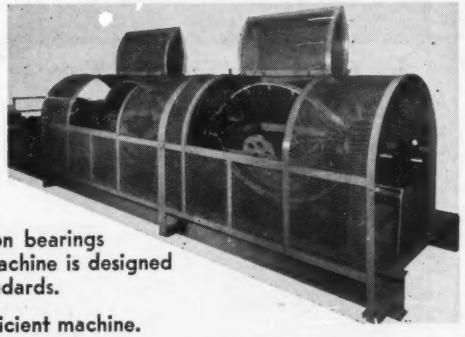


Built to handle wire from #14 to 500,000 circular mils in size on cradle reels.

Cradle reels either 30", 36" or 48" in diameter.

Rotor speeds from 800 r.p.m. to 30 r.p.m. controlled by gear box and dual drive.



Capstans either single with fleeter sheave as shown or double with diameters of 30", 36" or 42". Rates of lay from 1½" to 36".

Welded steel frame, anti-friction bearings and multiple roll guides. The machine is designed and built to our usual high standards.

An exceedingly versatile and efficient machine.

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with the finished ware; by a thin film of flux that has spread over to the withdrawal side of the bath (great care should be exercised to keep the flux tightly confined to the flux box); or by the pails being stored in a damp warehouse. Chilling in water to obtain a greater production will also produce this white clouded coating.

★ ★ ★

21. SPEED:—The speeds as given on the questionnaires varied from 13 dozen per hour to 37 2/3 dozens per hour with an average speed of 20 dozen to the hour (the proper production has been given in a table in a previous article). The grade A was given for speeds of 29 to 37 2/3 dozens per hour; the grade B for speeds of 21 to 29 dozens per hour; and the grade C for speeds of 13 to 21 dozens per hour. It can be said in general that the lower the speed the higher the quality of the finished product.

★ ★ ★

22. SMOOTHNESS OF COATING:—A rough coating may be caused by dross in the coating, by drip down the sides, by scum in the coating and by excessive metal deposited due to the poor quality condition of the galvanizing bath. The coating on some of the pails was beautiful and smooth, while on others it was very heavy, rough and uneven.

★ ★ ★

23. BARE PLACES FROM PILING TOO HOT:—This defect is the scraping off, or marring, of the coating by piling, or nesting the pails before the zinc has set. A few of the shipments showed these scraped places on an extremely large number of pails. The obvious remedy to this defect is to see that the metal has set before nesting, or set up more piles of pails to cool.

★ ★ ★

24. BURNT COATING INSIDE FROM PILING TOO HOT:—This defect may be caused by nesting the pails so hot that the heat in the bottom rim of the inside pail burns the coating of the pail in which it is nested. This defect often appears as a blue ring on the

coating inside the pail about 1 1/2 inches above the bottom. The blue color is caused by the flux, or by the oxide of the zinc due to the excessive temperature.

★ ★ ★

The one outstanding fact seen as a result of this very extensive experiment conducted on a full plant scale, is that even for one item, like this 12-quart water pail, the results in practice vary over a wide range. Costs vary in proportion as each individual company has adhered to or violated the basic scientific principles of hot dip galvanizing, as discussed in this series of articles.

Chemical Products Launches Plant Expansion Program

In a move designed to double their plant area, **Chemical Products Corporation,** East Providence, R. I., has broken ground for a multi-storied addition.

★ ★ ★

William I. McGowan, President, stated that the new building is part of the company's long-range development plans, laid many years ago. These plans not only include growth in sales and personnel but in the physical apparatus of the organization.

★ ★ ★

Included in the new $500,000 building will be greatly enlarged facilities for the manufacture of the well-known plastisol formulation, Chem-O-Sol. There will also be an extensive expansion of the laboratory and research departments to continue the development of new uses for Chem-O-Sol. Chem-O-Sol is already being used in many fields to improve on old products and to create new ones. Coating glass fibres to be woven into screening, water-proofing automobile lamp sockets, spraying on barrel interiors—are only a few of the many uses of this versatile basic material. It is expected that the new research facilities will greatly expand the field for new applications of Chem-O-Sol.

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For the past ten years we have specialized in the compounding of Vinyl extrusion and injection molding compounds to specifications, or developing compounds for a specific use.

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If you require a Vinyl compound rated higher than 105 degrees C for special applications, we suggest you communicate with us, as we may have a compound to meet your requirements.

Your inquiries are invited.

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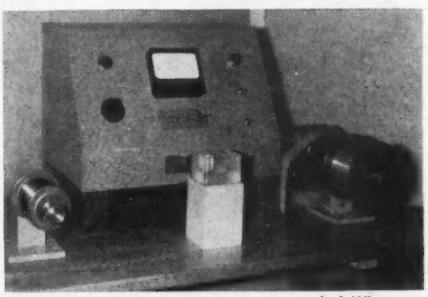

Federal Continuity Tester for Enameled Wire

Built to meet NEMA Specifications in the 5.3.2 range, 20 to 300 volts D.C. Furnished complete with mercury electrodes and pay-off and take-up equipment. 110 volt fully automatic gearhead motor.

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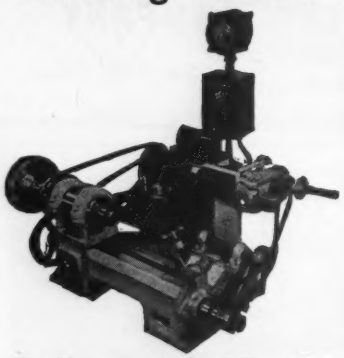

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The Standard of the Wire Industry

Revised Booklet on Joining Stainless Steel Issued by Crucible Steel

Crucible Steel Company of America announces the availability of a newly-revised 24-page booklet entitled "The Joining of Crucible Rezistal Stainless Steels."

★ ★ ★

Written by **Jack Goodford,** chief welding engineer for Crucible, the booklet describes in detail 17 methods employed in joining stainless steel by fusion processes.

★ ★ ★

These processes include manual, automatic, and semi-automatic welding, brazing, and soldering.

★ ★ ★

The booklet also contains a section describing eight flame and arc cutting procedures commonly used for severing stainless steel.

★ ★ ★

For a copy of this publication write the Advertising Department, Crucible Steel Company of America, Box 88, Pittsburgh 30, Pa.

Booklet on Pickle House Equipment

A new booklet, "Equipping the Pickle House," is offered by **The International Nickel Company** as a practical guide to greater production at lower cost in a wide variety of pickling operations.

★ ★ ★

The 32-page, two-color booklet describes the use of specially designed Monel equipment in the processing of large and small fabricated parts, forgings and castings, as well as the common mill forms of steel and tin plate. It explains how Monel's corrosion resistance, strength and ductility cut dead weight, permit greater payloads and assure longer service life.

★ ★ ★

More than 70 photographs illustrate practical applications of Monel in sling chains, yokes and special hooks, crates, racks, baskets, drums and other batch handling accessories and in hold-down rolls, lifting arms, pinch rolls, tank guides, and other parts exposed to corrosive conditions in continuous pickling lines. Diagrams and a table of link specifications showing

WHAT'S IN A SLOW BURN?

There's more to a slow burn than just temper.

When radio or TV hook-up wires get crossed, there may not always be sparks but there's a lot of heat generated — sometimes enough to start a good flame on the insulation.

When this sort of thing happens, the flame can be retarded and even extinguished if a NELCO saturant has been used on the insulation. Our laboratories worked long and hard to discover just the right combination of materials that would give a fire-retardant saturant that would also meet all other requirements of the radio and TV hook-up wire people.

The NELCO saturant we have developed, besides its outstanding characteristic of being a fire-retardant, has many other fine qualities. For example:

Its lightness in color makes wire more attractive, more sellable.

Its resistance to discoloration means finished wire that will not fade or become untraceable.

Its quick-drying properties, essential in mass production operations, are unequalled.

Here is another NELCO saturant, specially developed to do a tough job . . . as are all our saturants and lacquers.

When you do a slow burn over inefficient saturants, write to us for help. We're used to finding just the right solution for other people's problems.

Chemical Products
CORPORATION
King Philip Rd., East Providence, R. I.

safe loads for Monel chains are also included.

★ ★ ★

A final chapter describes the machining, welding, shaping and forging of Monel, and lists Inco's technical bulletins on these operations.

★ ★ ★

Address requests to Dept. J., International Nickel Company, Inc., 67 Wall Street, N. Y. 5, N. Y.

Norton Building New West Coast Plant

A new plant for the manufacture of grinding wheels is being equipped and will be opened January 1, 1956 at Santa Clara, California, by **Norton Company** of Worcester, Mass.

★ ★ ★

The one-story plant at 2555 Lafayette Street, 45 miles south of San Francisco, was purchased last Fall. Intentions at first were to use it as a warehouse. However, in the interests of providing better service to customers in the far west, it has been decided to set up manufacturing operations in the midst of the rapidly expanding West Coast market. The new Norton plant, the first on the West Coast to manufacture a full line of vitrified, organic and diamond wheels, will begin production late this year.

★ ★ ★

Renovating and equipping the plant will cost about a million dollars. Much of the equipment is now being purchased or specially built by Norton Company to conform to the most modern wheel making methods used at the main plant in Worcester.

★ ★ ★

George A. Garrison has been named plant manager. Mr. Garrison was formerly superintendent of packing and shipping at the Worcester plant. Since 1946, when he joined the company he has also served in the manufacturing control department, and industrial engineering, before starting in the packing and shipping department as an assistant foreman. A graduate of Norwich University at Northfield, Vt., he served four years in the Army.

Announcing a New Line of

WIRE DRAWING COMPOUNDS

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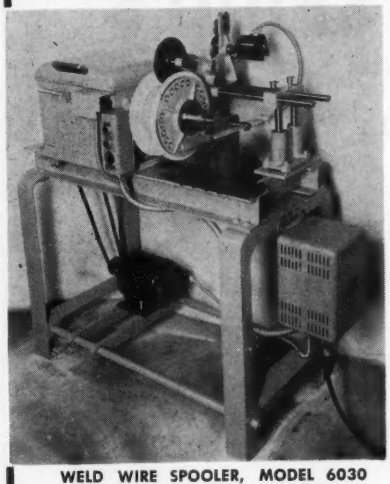
SPOOLER FOR WELD WIRE



WELD WIRE SPOOLER, MODEL 6030

SPOOLING AND COILING MACHINES FOR ALL PURPOSES

THE BOYD 6030 SPOOLER

is designed for the thread layer winding of weld wire. The traverse mechanism is a single screw solenoid actuated for positive "No-dwell" reversing running in a constant shower of oil. Traverse lengths are easily adjusted from one-half to eight inches or longer if desired. Therefore, this machine can be used for other winding requirements.

Ball bearings throughout give free running and long life to all wear points.

Predetermining counter and measuring device provide automatic stop of wind at desired footage and hand operated clutch allows manual control.

The tailstock has a quick release action either hand or foot controlled.

The machine is powered by a motor with control for slow starting.

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ASTM Actions Relating to Wire

Standard Method of Test for Diameter by Weighing of Fine Wire Used in Electronic Devices and Lamps **(B 205)** was reverted to tentative status with revisions which specify the weighing equipment and the size of the balance in terms of the weight of the test specimen. In these revisions the conditions under which the average of multiple test specimens are used for determining wire size are more closely defined.

★ ★ ★

Committee D-9 proposed deletion from Tentative Methods of Sampling and Testing Untreated Paper Used for Electrical Insulation **(D 202)** of the tests for water-soluble sulfates which are now considered superfluous in electrical insulating papers when the pH and water extract and water conductivity tests are made. For this reason deletion of the reference to the water-soluble sulfates method **D 1099** was recommended.

The Diamond Tool Industry in 1954

This is the 10th successive report in this series on the Diamond Tool Industry. It is divided into 18 sections, for instance, scientific aspects, hardness and microhardness, surface finish testing, fine boring and turning, truing of grinding wheels, wire drawing, diamond salvage, diamond polishing, etc. In each of these sections it is referred to outstanding work published during 1954 and in some instances also to publications in 1953. The publication of 12 pp contains about 200 references. The literature referred to in this report can be obtained on loan, in England only, on application to the **Industrial Diamond Information Bureau,** St. Andrew's House, 32-34 Holborn Viaduct, London, EC 1.

New Bulletin on Low Temperature Brazing

Bulletin No. 68 issued by **Handy and Harman,** 82 Fulton St., New York 38, N. Y., is devoted to illustrated descriptions on how to raise

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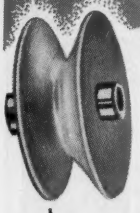

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the output of brazed parts through the use of "Easy-Flo," "Sil-Fos" and "Handy Flux."

★ ★ ★

Copies of the bulletin will be mailed you upon request to the company.

Encyclopedia Handbook Published in England

The Wire Industry Ltd., 33 Furnival St., London, E. C. 4, has issued the 1955 edition of the Wire Industry Encyclopedia Handbook for the Wire Drawing and Fabricating Industry.

★ ★ ★

The book covers a trade summary for 1954, a buyers' guide to supplies, list of brand trade names, a short list of selected articles on processes, equipment, etc., a list of technical and commercial terms used in the industry and a section of wire gauges and other tables.

★ ★ ★

Copies may be ordered from the publisher.

Develops Tap-Proof Cable

Kenneth H. Schmidt, who heads **Research Products, Inc.,** Danbury, Conn., is reported to have developed and patented a new telephone cable construction that is claimed to be tap-proof. So far it has been applied to interoffice communications in the Pentagon Building.

★ ★ ★

The key to the cable is a spiral copper foil under the constant supervision of an ultra-sensitive relay that responds to any current change exceeding two millionths of an ampere. Any attempt to cut, pierce or remove the shielding sets off an alarm in the control unit. Tapping is frustrated by a signal jamming device.

★ ★ ★

Mr. Schmidt was in radio work before he joined the Signal Corps in 1941 to become communications maintenance chief at Fort Riley. Later, he became chief engineer of the White House communications system, where he developed several devices used by the Secret Service. He organized Research Products, Inc., in 1949.

Steel Company of Canada to Expand

A new era of expansion, based on a forecast that Canadian steel consumption will increase 25% by 1961 from the 1951-53 average, was announced by **H. G. Hilton,** president of the **Steel Company of Canada** at the annual meeting at Hamilton, Ontario.

★ ★ ★

The expansion at an unstated cost includes a second blooming mill, additional capacity in rolling mill departments, development of a Quebec iron ore mine and a new wire mill.

★ ★ ★

This is in addition to a $23 million expansion remaining to be completed at the end of 1954.

★ ★ ★

A 25% increase in the present capacity is almost as great in tonnage as was the 50% increase over 1949 capacity, he noted.

★ ★ ★

Another Great
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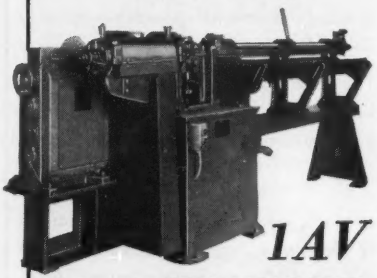
NEW! Electrically controlled Clutch and Target!



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- Basic Wire 3/32" to 1/4"
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100 Grit
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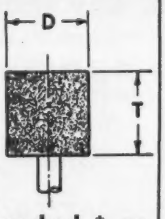
mounted on mandrel 1½" long, ⅛" diam. Those marked * on ¼" diam. mandrel.



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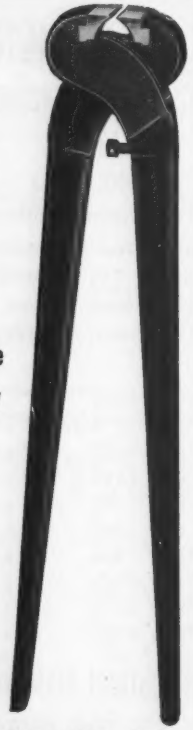

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A new wire mill will cost about $5 million. Ultimately all Hamilton wire production will be concentrated in this mill, with ample provision for future growth. Tenders are to be called on this project shortly.

★ ★ ★

Business increased rapidly in the first few weeks of 1955 with the company setting new monthly records in March in ingot production and blooming mill output.

★ ★ ★

Shipments in the first quarter of the year were well above last year and it looks as though the steel business has acquired sufficient momentum to support a good rate of production well into the last half, Mr. Hilton predicted.

1954 ASTM Proceedings Published

The 1954 edition of the ASTM Proceedings is now available. The 1400-page volume records the technical accomplishments of the **American Society for Testing Materials** for last year. It includes many technical reports and papers together with discussions offered to the Society during the year and accepted for the Proceedings.

★ ★ ★

Leading the volume is the Summary of the Proceedings of the 57th Annual Meeting, held in June 1954, listing by title and author the program for each of 36 sessions.

★ ★ ★

Reports of the technical committees, 68 in all, and the 37 technical papers cover a wide variety of subjects pertaining to research and testing.

★ ★ ★

There are listed also in the table of contents all symposiums published separately as Special Technical Publications and all papers published in the ASTM Bulletin.

Bristol Brass Elects Gay Chairman

At the annual meeting of the board of directors of the **Bristol**

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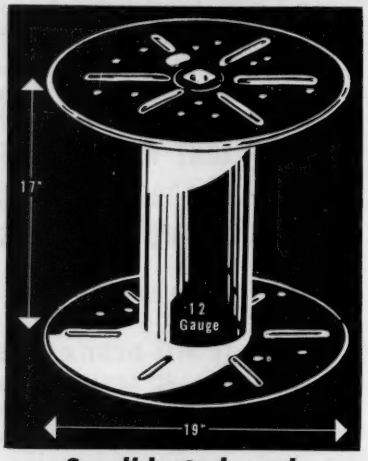

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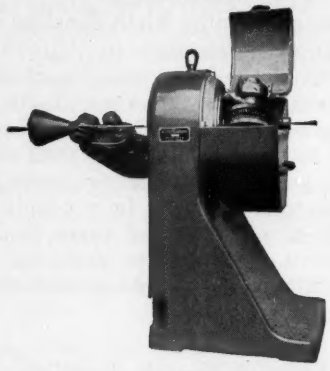

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Brass Corporation yesterday, **Roger E. Gay,** president, was elected chairman of the board and given a leave of absence to accept the position of Director, Division of Cataloging, Standardization, Inspection and Quality Control in the Office of Assistant Secretary of Defense (Supply and Logistics).

★ ★ ★

Mr. Gay succeeds as chairman of the board, **C. T. Treadway, Sr.,** who has served in that capacity since 1951 and who will continue as a member of the board.

★ ★ ★

During Mr. Gay's absence, the executive committee and the board of directors will direct the affairs of Bristol Brass, with Joseph O'-Brien, vice president and general superintendent as operating head of the company.

★ ★ ★

Chairman of the executive committee will be **Otto von Au,** former president of the **Accurate Brass Company,** predecessor of the Accurate Brass Corporation, a wholly owned subsidiary of Bristol Brass, and more recently a consultant to the new company. He has been associated wiith Accurate Brass and the brass industry for more than 35 years.

★ ★ ★

Mr. Gay, who has been president of the **American Standards Association** for the past three years, has been serving as part-time consultant to the Department of Defense and will now devote full time to the program of standardization for the unified armed services.

★ ★ ★

He was elected president of Bristol Brass in 1943 to become the youngest chief executive in the 105-year history of the company. He first joined the company in 1938 as assistant to the president, following several years with the American Brass Company where he became an assistant sales manager.

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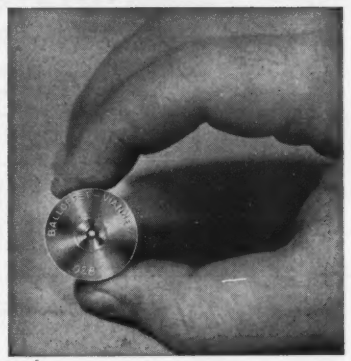

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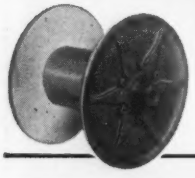

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Wires Straightened and Cut to length—Small Gauges—Small orders our specialty
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Appoints Assistant District Manager in Detroit

Firth Sterling Inc. has announced the appointment of **Vaux H. Adams** as Assistant District Manager in the firm's Detroit District.

★ ★ ★

Before joining Firth Sterling in 1950 as a salesman in that District, Mr. Adams was associated for six years with a major carbide producer in shop assignments leading to research engineer and for four years with a leading specialty steel manufacturer in production and sales. He served three years with the U. S. Air Force as a commissioned officer and attended Butler University.

Metal & Thermit Appoints New Executive Advisor

Merritt L. Smith has been appointed Executive Advisor of **Metal & Thermit Corporation,** producers of metals, industrial chemical and welding equipment and supplies, it was announced by **H. E. Martin,** President. As staff coordinator, Mr. Smith will assist the president in integrating the company's varied sales activities.

★ ★ ★

Mr. Smith's experience covers more than twenty years in sales administrative work concurrent with advertising. He was for four years Assistant General Sales Manager, and prior to his present appointment was Manager of Advertising and Sales Promotion.

Republic Metallurgist Transferred to Beaver Falls

Appointment of **Ralph A. Creter** as plant metallurgist for **Republic Steel Corporation's Union Drawn Steel Division** plant in Beaver Falls, Pa., has been announced by **H. B. Anderson,** plant superintendent. He succeeds Harold Seyler, who died recently.

★ ★ ★

Until his new appointment Creter was a laboratory metallurgist at Union Drawn's Massillon, Ohio, plant. He has been associated with Union Drawn in a variety of metallurgical capacities since 1927.

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"Manufacture and Properties Of Steel Wire"

A new book by Anton Pomp, Dr. Eng. translated from German into English by C. P. Bernhoeft, Dipl. Eng., and published by The Wire Industry, London, Eng. It contains 358 pages of text and sells for $11.80 per copy.

It is the most up-to-date treatise on steel-wire manufacture available and covers the latest developments in wire processing, such as mechanical descaling, increased drawing speeds and lubricants for these high speeds, die shapes and modern testing procedures. The entire range of wire manufacture, from rods to finished products are discussed.

Copies may be ordered through

•

WIRE & WIRE PRODUCTS

453 Main Street, Stamford, Conn.

Oakite Establishes Export Division

Oakite Products, Inc., manufacturers of specialized industrial cleaning and related materials, have announced the formation of an Export Division to handle the demand from Latin American and overseas companies. **Harry V. Kerker,** with Oakite since 1943, has been appointed manager.

★ ★ ★

Oakite manufactures specialized alkaline, solvent, and acidic detergents for the removal of all types of industrial soils from machinery and from metals in production, as well as conveyor chain lubricants, metal drawing and burnishing compounds, the Oakite CrysCoat phosphating process, etc.

★ ★ ★

Oakite also manufactures cleaning equipment—steam guns, hot spray and foam units—for the application of Oakite cleaning materials, to reduce cleaning time and costs. The company maintains extensive laboratory facilities, including a customer service laboratory.

★ ★ ★

In announcing the formation of the new division, **John A. Carter,** president of Oakite, cited the growth of the company since 1909. The company now manufactures more than 115 different materials and serves more than 35,000 customers in the United States and Canada.

★ ★ ★

Booklets describing Oakite's operations in each industrial field are available from the Export Division, Oakite Products, Inc., 152A Rector St., New York 6, N. Y.

Brand Dedicates New Mill

A new plant to manufacture Turbo plastic insulated wire and cable and electrical insulating tubing was dedicated on May 25, at North Windham, Conn., by **William Brand,** President of **William Brand & Co., Inc.** of Willimantic. Speaking at the ceremonies, in addition to local city and town officials, was the Honorable **Abraham Ribicoff,** Governor of the State of Connecticut.

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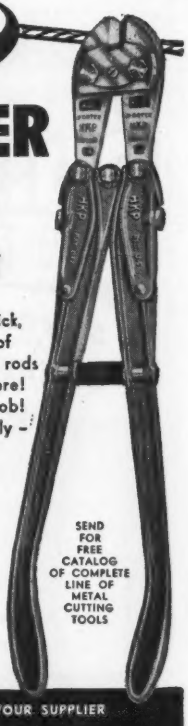

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William Brand & Co. are suppliers to the automotive, aviation, business machine, communication, electric, electronic and associated industries. This addition makes possible the continued growth and expansion of the corporation founded 35 years ago.

★ ★ ★

The new building, an approximately 60,000 sq. ft. "daylight plant," replaces the old 35,000 sq. ft. South Street factory. Built at a cost in excess of $500,000, the facilities are equipped with the latest wire and tubing extruders, as well as the most modern high temperature ovens for the production of silicone and silicone rubber coated fibrous glass sleeving.

★ ★ ★

William Brand & Co. was formed in New York City for the purpose of importing varnished cotton tubing and fabricated mica parts for resale to radio and automobile manufacturers in 1920.

★ ★ ★

In the mid 1930's when European sources of supply became less dependable, plans were laid for the establishment of an affiliated company. This plant started operation in 1939 in Willimantic with 37 employees and an annual payroll of $35,000. Currently 250 people are employed with an annual payroll of $950,000.

★ ★ ★

During the war the company enjoyed substantial growth: 65% of all varnished tubing used domestically in the war effort bore the Turbo brand. Additional products were added during this period—wire markers for the identification of electronic circuits and aircraft harnesses in 1941 and extruded plastic tubing in 1942. Fine gauge plastic insulated wire was introduced to the product line in 1945 and soon became a major sales item.

★ ★ ★

In 1950 an additional building was acquired on North Street in Willimantic. The New York sales offices were closed, a merger was effected and the corporation continued under the name of William Brand & Co., Inc. in Willimantic with **William Brand** as president and **Alfred W. Brand** as executive vice president.

★ ★ ★

Increased emphasis is being placed on research and development. Laboratory space has been increased from 1500 sq. ft. in the old South Street plant to almost 3,000 sq. ft. in the new structure. In past years the laboratory has worked closely with the armed services and government contractors in developing plastic formulations for military and commercial applications. This work is continuing with many important confidential projects under way.

★ ★ ★

After August 1, when all equipment will have been installed and the plant in full operation, visitors will be welcome to tour the expanded facilities.

New Copperply Jewelry Wire Developed

A new knurled copperply wire has been developed expressly for the costume jewelry trade by the **Worcester Wire Works, Division of National-Standard Co.,** Worcester, Mass.

★ ★ ★

Rolled in two planes and giving the grooved effect of a gear, the new wire is annealed for easy forming and resistance to breakage. The tiny facets of the knurled surface pick up light reflection, resulting in a glittering effect that is said to contribute greatly to the appearance of costume jewelry.

★ ★ ★

The new Copperply product is not to be confused with any of the coated or clad wires on the market. Copperply is steel wire electroplated with copper to controlled thickness and provides a precisely uniform copper covering with a performance and service life equal to, or excelling that of solid copper wire for jewelry service, but at a much lower cost.

Dictionary of Cold Finished Steel Terms Offered

A 32-page dictionary of steel terms of particular value to men who buy or use cold finished steel bars is available from the **LaSalle Steel Company.** This booklet is titled "Simplified Steel Terms and Engineering Data." Included are more than 180 relatively detailed definitions frequently used in the purchase, manufacture, treating, machining and finishing of steel.

★ ★ ★

Terms defined range from Annealing and Austempering through Isothermal Quenching and Macro-Etching to Spheroidizing, Stress Relieving and Yield Strength.

★ ★ ★

More than 30 photographs, curves and tables cover subjects such as Standard Grain Sizes for Steels, Shepherd Grain Size Fracture Standards, Approximate Hardness Conversion Number for Steel, based on Brinell, Iron, Iron Carbide Equilibrium Diagram, method of determining hardenability and Izod toughness vs tensile strength of heat treated steels.

★ ★ ★

Copies are available without charge from LaSalle Steel Company, Chicago 80, Illinois.

Rope Company Elects New President

Joseph H. Bascom, formerly executive vice president and treasurer, was elected president of **Broderick & Bascom Rope Co.,** St. Louis. He succeeds **C. E. Bascom,** who has become chairman of the Board. At the same time **Stanley R. Brenner,** vice president-operations, was elected a director and **A. A. Grosse,** secretary and assistant treasurer, was elected secretary-treasurer.

Elected V.P. of Celanese

Richard W. KixMiller has been elected vice president in charge of the chemical division of **Celanese Corporation of America.** He joined the company in 1946, and in 1952 was named general manager of the chemical division.

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washington, pennsylvania

Auto-Lite Expanding Two Electric Wire Plants

Expansion of facilities at its wire and cable plants at Port Huron, Mich., and Hazelton, Pa., has been announced by **The Electric Auto-Lite Company.** Total cost of the projects is expected to be about $1,200,000, which will be completed in the Fall.

★ ★ ★

The transition of 12-volt electrical systems by some of Auto-Lite's car manufacturer customers was given as the reason for the need for additional manufacturing facilities, **H. E. Hasemeyer,** vice president in charge of production, reported, since a 12-volt generator, for example, must have greater lengths of wire of a smaller diameter than its six-volt counterpart.

★ ★ ★

Largest undertaking will be at the company's Port Huron plant, where 50,000 square feet of manufacturing space will be added. Engineering facilities also will be enlarged. New equipment, including magnet wire enameling ovens and wire drawing machines, will be purchased.

★ ★ ★

Since the Hazelton plant is capable of absorbing the necessary new equipment no additional manufacturing space will be constructed there. However, some $200,000 will be spent there to provide production facilities capable of handling wire volume for 12-volt electrical equipment, he said.

New Machinability Computer

A new electronic machinability computer announced by **Carboloy Department of General Electric Company,** Detroit 32, recently, promises to make life of the tool engineer less complicated. It will solve machining problems in less than 2 minutes with reasonable accuracy that normally would take several hours to compute.

★ ★ ★

The computer will enable a methods and service man to determine quickly whether or not he is using a correct set of conditions for machining; help him arrive at a proper set of conditions for setting up a new machining operation, or indicate to him the relative advantages of changing some of the present job conditions to obtain greater production.

★ ★ ★

The 32 pound, self-powered analog unit measures 21 x 7 x 20 inches, and will consider 14 operational variables in machining, such as grade of carbide, speed, feed, depth of cut, tool life, alloy, material hardness, etc.

★ ★ ★

It can be fed information on any of 13 variables and come up with the 14th, or the answer. It also will consider five variables that affect the motor horsepower required to do a machining job, pro-

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1 NEW INDUSTRIAL OVEN - DUAL HYDRAULIC TAKEUP STAND

7 SYNCRO BB-13 13-DIE WIRE-DRAWING MACHINES

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Executive Secretary

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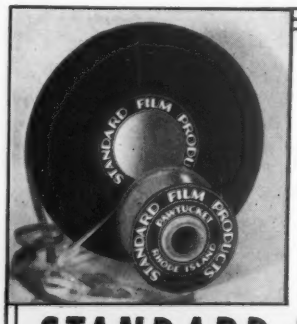

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viding the answer after being fed with information on four variables.

★ ★ ★

The computer was developed by **Dr. W. W. Gilbert,** formerly with the University of Michigan, now associated with G.E.'s Manufacturing Services Division, Schenectady, N. Y., after correlating basic data largely from General Electric experience in machining. It has been field tested for more than a year in G.E.'s operating components.

★ ★ ★

The new computer, to sell for approximately $500 will be available after September 1st. Orders may be placed now.

New Bulletin on Drawing Equipment

The Aetna-Standard Engineering Company announces release of new eight-page product information bulletin on Cold Drawing equipment.

★ ★ ★

Includes illustrations and information on Dual Chain, Triple Draw, Single Draw and 5-Draw Benches; Piercing Mill, Bull Block, Cold Reducing Mill; Squeeze Pointers; Air Operated Carriages and Hook; information on drawing speeds, die mountings, length of draws, carriages and tube pushers. Available from The Aetna-Standard Engineering Company, Frick Building, Pittsburgh 30, Pa.

New Patenting Furnace Installed by Roebling

A new patenting furnace has been installed at the Roebling, New Jersey, works of the **John A. Roebling's Sons Corporation,** it was announced by **Raymond S. Worth,** manufacturing manager of the Company's steel wire mills division. Installed in the Division's galvanizing shop, the new furnace has already undergone successful test runs.

★ ★ ★

The new patenting installation coupled with a galvanizing furnace makes for a highly versatile and flexible unit, providing for four basic types of operations. According to Mr. Worth, the modern patenting furnace will add important new production facilities expediting the efficient manufacture of a wide variety of wire and wire products.

★ ★ ★

The Roebling Corporation, a wholly owned subsidiary of **The Colorado Fuel and Iron Corporation,** manufactures a wide variety of wire and wire products for hundreds of applications ranging from the finest watch spring wire, to electrical conductors and giant cables for bridges.

Delay in Filling Book Orders

To the many persons who have placed orders recently for the book: "The Manufacture and Properties of Steel Wire," there will be

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★ ★ ★

The accumulation of goods for out-of-country shipment is heavy, but the publishers assure us that the books will be mailed as soon as the post office can handle them.

New Film on Brass Available for Group Showing

Workers in brass rod or wire, or those who use non-ferrous forgings, will be interested to know that **Chase Brass & Copper Co.** has released a new industrial film titled "In the Chips"—a 16mm sound and color film of 24 minutes. It is available free upon request to responsible firms, trade associations, technical groups and employee training classes.

★ ★ ★

Described as an exciting, informative motion picture, "In the Chips," in grapnic close-ups and with animated drawings, gives a clear insight as to what happens when a tool bites into free-cutting brass rod, why short chips mean easier machining, smoother and cleaner final surface, and how proper alloying of the rod in the mill can increase tool life.

★ ★ ★

Applications for this film should be addressed to Chase Executive Offices, Waterbury 20, Conn., or to the nearest Chase warehouse or sales office listed below: Atlanta, Ga.; Boston, Mass.; Chicago, Ill.; Cleveland, Ohio; Detroit, Mich.; Los Angeles and San Francisco, Calif.; Milwaukee, Wisc.; New York, N. Y.; Philadelphia, Pa.; Seattle, Ore.; Rochester, N. Y., or Providence, R. I.

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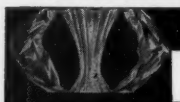
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Vacuum melted alloys make possible the production of alloys practically free of inclusions, closer composition control, higher fatigue strength, greater ductility and lowered costs.

* * *

One example is gas turbine components. New alloys will have so much better properties that it is expected they will break the bottleneck of cost and suitable materials for the mass production of the gas turbine auto package, about which so much has been heard recently.

* * *

From the wire man's point of view, certain difficult-to-draw spring wire alloys may be drawn to finer sizes, with improved surface finishes and fewer breakages.

* * *

There are many other aspects and advantages to vacuum melted alloys that the company will be pleased to discuss with interested persons upon request.

Aetna Standard Expanding Elwood City Plant

Aetna-Standard Engineering Company, Pittsburgh, Pa., has begun work on its second post-war multi-million-dollar expansion program at its Elwood City plant, **Ernest E. Swatswelter,** chairman and president, disclosed recently.

★ ★ ★

He said the new program will increase the plant's productive capacity 30%. First orders for new machine tools to equip it have been placed. The program calls for extending four buildings, installing more equipment and employing more help.

★ ★ ★

Aetna-Standard completed a major expansion only a few years ago.

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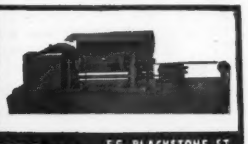

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Mr. Swartswelter said the company's backlog of orders has virtually doubled in the last three months. The orders, he said, are well diversified and include equipment for galvanizing, tinning, cold-drawing and others.

★ ★ ★

He added foreign orders also are coming in at a good rate, with most of these going to associated companies in Germany, France and England.

Horn Retires from Wheeler Wire

George B. Horn, Vice President and General Manager of **The Wheeler Insulated Wire Co., Inc.,** a division of **The Sperry Corporation** retired on May 31st after 22 years service with the company.

★ ★ ★

Mr. Horn has been associated with the wire and cable and electronics industries for over 41 years, starting with the **General Electric Company** in 1914. A graduate of Purdue University's School of Engineering, he has also held management positions with **Dudlo Mfg. Corp.,** Ft. Wayne and **General Cable Corp.,** Rome, N. Y.

★ ★ ★

He joined Wheeler as Chief Engineer in 1934; later he was named Vice President and Works Manager, and in 1953 was appointed General Manager.

★ ★ ★

For many years Mr. Horn has been a member of NEMA and has served on various of its committees. He has also been active in the following trade organizations: Institute of Radio Engineers, Society of Automotive Engineers, and the American Institute of Electrical Engineers, The Wire Association.

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Naugatuck Chemical Div., U. S. Rubber Co., New York, N. Y.

COMPOUNDS—Wire Drawing
Apex Alkali Products Co., Philadelphia, Pa.
Ironsides Co., The, Columbus, Ohio.
Magnuson Products Corporation, Brooklyn, N. Y.
Miller, R. H. Co., Inc., Homer, N. Y.
Nopco Chemical Co., Harrison, N. J.
Pacific Coast Borax Co., New York, N. Y.
Rome Soap Manufacturing Co., Rome, N. Y.
Standard Industrial Compounds Co., Chicago.
Swift & Company, Chicago, Ill.

CONDUCTORS—Flexible, Electrical
Montgomery Co., The, Windsor Locks, Conn.

CONTAINERS—Wire Packaging
(See DRUMS—Wire Packaging)

COPHOLDERS—Steel
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Wire & Textile Mach'y, Inc. (used) Pawtucket. R. I.

CORDS—Electrical, Tinsel Conductor
Montgomery Co., The, Windsor Locks, Conn.

COUNTERS—
(See MACHINERY—Measuring Wire and Cable)

CRANES—Wire Mill
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, O.
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

CUTTING TOOLS—Carbide
Carboloy Dept. of General Electric Co., Detroit.
Eastern Carbide Corp., New Rochelle, N. Y.
Firth Sterling, Inc., Pittsburgh, Pa.
Metal Carbides Corporation, Youngstown, Ohio
Vascoloy-Ramet Corp., Waukegan, Ill.
Willey's Carbide Tool Co., Detroit, Michigan.

CUTTING TOOLS—Wire
Porter, H. K. Inc., Somerville, Mass.
Robinson, M. W. Co., Rockfall, Conn.

DIAMONDS—Industrial
Balloffet-Vianney Wire Die Co., Inc., Guttenberg, N. J.
Molina-Straus Diamond Products Co., New York, N. Y.
Rusch Wire Die Corp., Croton-on-Hudson, N. Y.
United States Industrial Diamond Corp., New York, N. Y.
Wayne Wire Die Co., Hillside, N. J.

DIAMOND POWDERS—
Danforth, The C. W. Co., Youngstown, Ohio
Elgin National Watch Co., Abrasives Div., Elgin, Ill.
Hyprez Div., Engis Equipment Co., Chicago, Ill.
Indiana Wire Die Co., Ft. Wayne, Ind.
Industrial Diamond Powders, Inc., Pittsburgh, Pa.
Kelly Wire Die Corp., New York, N. Y.
Molina-Straus Diamond Products Co., New York, N. Y.
National Research Company, St. Clair Shores, Mich.
New England Wire Die Co., Worcester, Mass.
Rusch Wire Die Corp., Croton-on-Hudson, N. Y.
United States Industrial Diamond Corp., New York, N. Y.
Universal Wire Die Co., Cranford, N. J.
Wayne Wire Die Co., Hillside, N. J.

DIAMOND POWDER RECLAIMING—
Danforth, The C. W. Co., Youngstown, Ohio
Industrial Diamond Powders, Inc., Pittsburgh, Pa.
Kay & Warren Co., Brooklyn, N. Y.
Kelly Wire Die Corp., New York, N. Y.
National Research Co., St. Clair Shores, Mich.
Rusch Wire Die Corp., Croton-on-Hudson, N. Y.

DIAMOND TOOLS—
Indiana Wire Die Co., Ft. Wayne, Ind.
Metal Carbides Corporation, Youngstown, Ohio
Molina-Straus Diamond Products Co., New York, N. Y.
Universal Wire Die Co., Cranford, N. J.
Wayne Wire Die Co., Hillside, N. J.
Willey's Carbide Tool Co., Detroit, Michigan.

DIES—Carbide, Tungsten & Tantalum
Balloffet-Vianney Wire Die Co., Inc., Guttenberg, N. J.
Boulin, Victor J., Inc., New York, N. Y.
Carboloy Dept. of General Electric Co., Detroit.
Eastern Carbide Corp., New Rochelle, N. Y.
Firth Sterling, Inc., Pittsburgh, Pa.
Indiana Wire Die Co., Fort Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corp., Youngstown, O.
Rusch Wire Die Corp., Croton-on-Hudson, N. Y.
Universal Wire Die Co., Cranford, N. J.
Vascoloy-Ramet Corp., Waukegan, Ill.
Wayne Wire Die Co., Hillside, N. J.
Willey's Carbide Tool Co., Detroit, Michigan.

DIES—Cold Heading
Carboloy Dept. of General Electric Co., Detroit
Eastern Carbide Corp., New Rochelle, N. Y.
Firth Sterling, Inc., Pittsburgh, Pa.
Indiana Wire Die Co., Ft. Wayne, Ind.
Metal Carbides Corporation, Youngstown, Ohio
Vascoloy-Ramet Corp., Waukegan, Ill.
Willey's Carbide Tool Co., Detroit, Michigan.

DIES—Diamond
Ajax Industrial Supplies, Inc., Fort Wayne, Ind.
Balloffet-Vianney Wire Die Co., Inc., Guttenberg, N. J.
Boulin, Victor J., Inc., New York, N. Y.
Cochaud Wire Die Inc., New York, N. Y.
Ft. Wayne Wire Die, Inc., Fort Wayne, Ind.
Indiana Wire Die Co., Ft. Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
National Wire Die Co., New York, N. Y.
New England Wire Die Co., Worcester, Mass.
Rusch Wire Die Corp., Croton-on-Hudson, N. Y.
Universal Wire Die Co., Cranford, N. J.
Wayne Wire Die Co., Hillside, N. J.

DIES DIAMOND—Reversible
National Wire Die Co., New York, N. Y.

DIES—Extrusion
Carboloy Dept. of General Electric Co., Detroit.
Eastern Carbide Corp., New Rochelle, N. Y.
Firth Sterling, Inc., Pittsburgh, Pa.
Metal Carbides Corporation, Youngstown, Ohio
Rusch Wire Die Corp., Croton-on-Hudson, N. Y.
Universal Wire Die Co., Cranford, N. J.
Wayne Wire Die Co., Hillside, N. J.
Willey's Carbide Tool Co., Detroit, Michigan.

DIES—Eyelet
Eastern Carbide Corp., New Rochelle, N. Y.

DIES—Nail, Nail Cutters, Feeder Blocks, Grippers, etc.
Firth Sterling, Inc., Pittsburgh, Pa.
Pittsburgh Carbide Die Co., Monongahela, Pa.

DIES—Pointing
Sjogren Tool and Machine Co., Auburn, Mass.

DIES—Repairs & Re-Cutting
Ajax Industrial Supplies, Inc., Fort Wayne, Ind.
Balloffet-Vianney Wire Die Co., Inc., Guttenberg, N. J.
Boulin, Victor J., Inc, New York, N. Y.
Carboloy Dept. of General Electric Co., Detroit.
Cochaud Wire Die Inc., New York, N. Y.
Eastern Carbide Corp., New Rochelle, N. Y.
Ft. Wayne Wire Die., Inc., Fort Wayne, Ind.
Indiana Wire Die Co., Ft. Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corporation, Youngstown, Ohio
National Wire Die Co., New York, N. Y.
New England Wire Die Co., Worcester, Mass.

WHERE TO BUY, Continued

For more complete information, consult the annual Wire and Wire Products Buyers' Guide.

Rusch Wire Die Corp., Croton-on-Hudson, N. Y.
Universal Wire Die Co., Cranford, N. J.
Vascoloy-Ramet Corp., Waukegan, Ill.
Wayne Wire Die Co., Hillside, N. J.

DIES—Special Shapes, Etc.
Eastern Carbide Corp., New Rochelle, N. Y.
Firth Sterling, Inc., Pittsburgh, Pa.
Indiana Wire Die Co., Ft. Wayne, Ind.

DIES—Swaging
Sjogren Tool and Mach. Co., Inc., Auburn, Mass.

DIES—Tube Drawing
Balloffet-Vianney Wire Die Co., Inc., Guttenberg, N. J.
Carboloy Dept. of General Electric Co., Detroit.
Eastern Carbide Corp., New Rochelle, N. Y.
Firth Sterling, Inc., Pittsburgh, Pa.
Indiana Wire Die Co., Fort Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corp., Youngstown, O.
Rusch Wire Die Corp., Croton-on-Hudson, N. Y.
Vascoloy-Ramet Corp., Waukegan, Ill.
Willey's Carbide Tool Co., Detroit, Michigan.

DRAW BENCHES—
(See MACHINERY—Draw Benches)

DRUMS—Wire Packaging
Continental Can Company, Van Wert, Ohio

DRUMS & TRAVERSES—For Cable Reels
Entwistle, James L., Co., Providence, R. I.
Hubbard Spool Co., Garrett, Ind.
New York Engineering Co., Yonkers, N. Y.
Republic Steel Corp., Pressed Steel Div., Niles, Ohio

DRYING EQUIPMENT
Carl-Mayer Corp., The, Cleveland, Ohio
Industrial Ovens, Inc., Cleveland, Ohio.
Michigan Ovens, Inc., Detroit, Michigan.
Rockwell, W. S. Co., Fairfield, Conn.

ENGINEERS—Consulting
Lubricants—Hans C. Bick, Inc., Reading, Pa.
Wire Mill—Clarence S. Arms, Worcester, Mass.
Zinc—Imhoff, Wallace G. Co., Los Angeles, Calif.
Seymour, Leroy D., Trenton, N. J.

EYELETS—Brass or Zinc
Platt Bros. & Co., The, Waterbury, Conn.

FENCING & FENCES—Wire
Interlocking Fence Co., Morton, Ill.

FILM—Insulating
Standard Film Products Corp., Pawtucket, R. I.

FINISHERS—Flame Proof, for Wire
Carbro Chemical Co., Pawtucket, R. I.

FOAM PRODUCING COMPOUNDS—
American Chemical Paint Co., Ambler, Pa.
Parkin Chemical Co., The, Pittsburgh, Pa.

FURNACES—Brazing
Electric Furnace Co., Salem, Ohio
Rockwell, W. S. Co., Fairfield, Conn.

FURNACES—Galvanizing Equipment
Ajax Electric Co., Inc., Philadelphia, Pa.
Electric Furnace Co., Salem, Ohio
Rockwell, W. S. Co., Fairfield, Conn.
Wilson, Lee, Engr. Co., Cleveland, Ohio

FURNACES—Heat Treating
Ajax Electric Co., Inc., Philadelphia, Pa.
Carl Mayer Corp., The, Cleveland, Ohio
Electric Furnace Co., Salem, Ohio
Drever Company, Phila., Pa.
Rockwell, W. S., Co., Fairfield, Conn.
Wilson, Lee, Engr. Co., Cleveland, Ohio

FURNACES—Lead Melting
Electric Furnace Co., Salem, Ohio
Rockwell, W. S. Co., Fairfield, Conn.

FURNACES—Pot (oil, gas, electric)
Ajax Electric Co., Inc., Philadelphia, Pa.

FURNACES—Resistance Heating, Strand
(See Annealing Machines)

FURNACES—Salt Bath
Ajax Electric Co., Inc., Philadelphia, Pa.
Electric Furnace Co., Salem, Ohio
Rockwell, W. S. Co., Fairfield, Conn.

GALVANIZING EQUIPMENT — (See MACHINERY—Galvanizing Wire)

GRINDERS—Roll
Norton Co., The, Worchester, Mass.

GUIDES—For Wire
Heany Industrial Ceramic Corp., New Haven, Conn.
Lignum-Viate Products Company, Jersey City, N. J.

GUIDE TIPS—For Extruding Machines (See NOZZLES)

HAMMERS—Nail Heading
Firth Sterling, Inc., Pittsburgh, Pa.
Pittsburgh Carbide Die Co., Monongahela, Pa.

HAMMERS—Swaging
Sjogren Tool and Machine Co., Auburn, Mass.

HARDSURFACING ALLOYS—
(See Alloys—Hardsurfacing)

HOOKS—Pickling & Liming
Lewis Welding and Engineering Corp., The, Bedford, Ohio
Youngstown Welding & Eng'g' Co., Youngstown, Ohio

HOISTS—Electric Travelling
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, Ohio

INHIBITORS—Pickling
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.
Parkin Chemical Co., The, Pittsburgh, Pa.

INSULATING MATERIALS—
Carbro Chemical Company, Pawtucket, R. I.
Celanese Corporation of America, New York, N. Y.
Chemical Products Co., E. Providence, R. I.
Electronic Rubber Co., Stamford, Conn.
Monsanto Chemical Co., St. Louis, Mo.
Naugatuck Chemical Div., U. S. Rubber Co., New York, N. Y.
Pittsburgh Plate Glass Company, Pittsburgh, Pa.
Plymouth Cordage Company, Plymouth, Mass.
Standard Film Products Corp., Pawtucket, R. I.
Synthetic Thread Corporation, Bethlehem, Pa.

INSULATING MATERIALS — Paper—For Electric Wire Cable
Plymouth Cordage Company, Plymouth, Mass.

KETTLES—Galvanizing
National Annealing Box Co., Washington, Pa.

LACQUERING SYSTEMS — See MACH.—Lacquering Electric Wire

LACQUERS—For Electric Wire
Chemical Products Co., E. Providence, R. I.

LAME—LAHN—
Kassel Export Company, New York, N. Y.
Montgomery Co., The, Windsor Locks, Conn.

LIME—
Warner Co., The, Philadelphia and Bellefonte, Pa.

LUBRICANTS — For Metal Cutting, Stamping and Drawing
Apex Alkali Products Co., Philadelphia, Pa.
Magnuson Products Corporation, Brooklyn, N. Y.
Miller, R. H., Co., Inc., Homer, N. Y.
Nopco Chemical Co., Harrison, N. J.
Standard Industrial Compounds Co., Chicago.

LUBRICANTS—Wire Drawing
(See Compounds—Wire Drawing)

LUBRICANTS—Wire Rope
Swift & Co., Chicago, Ill.
Ironsides Co., The, Columbus, Ohio

LUBRICANTS—for Metal Cutting, etc.
Ironsides Co., The, Columbus, Ohio

MACHINERY—Armoring (Cable, Wire, Hose)
American Insulating Mach'y Co., Phila., Pa.
Sleeper & Hartley, Inc., Worcester, Mass.
Watson Machine Co., Paterson, N. J.
Wire & Textile Mach'y, Inc., (used), Pawtucket, R. I.

MACHINERY—Barbed Wire
Glader Wm., Machine Works, Chicago, Ill.
Wafios, Maschinenfabrik, Reutlingen, Wurtt., Germany

MACHINERY—Bobbin Winders
Mummert-Dixon Company, Hanover, Pa.
Wire Equipment Mfg. Co., Trenton, N. J.

MACHINERY—Braiding
Fidelity Machine Co., Inc., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Wardwell Braiding Mach. Co., Central Falls, R. I.
Wire & Textile Mach'y, Inc. (used) Pawtucket, R. I.

MACHINERY—Bunching
Cook Manufacturing Co., The, Paterson, N. J.
Edmands Company, The, Providence, R. I.
Haskell-Dawes Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Niehaus, K. A., Maschinenfabrik, Dusseldorf-Rath, Germany
Sleeper & Hartley, Inc., Worcester, Mass.
Watson Machine Co., Paterson, N. J.
Wire & Textile Mach'y, Inc. (used) Pawtucket, R. I.

MACHINERY—Bundling, Scrap
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Cable, Electric
American Insulating Mach'y Co., Phila., Pa.
Fidelity Machine Co., Inc., Philadelphia, Pa.
Haskell-Dawes Machine Co Philadelphia, Pa.
New England Butt Co., Providence, R. I.
New York Engineering Co., Yonkers, N. Y.
Niehaus, K. A., Maschinenfabrik, Dusseldorf-Rath, Germany
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Capstans (See Machinery—Winding Wire)

MACHINERY—Centerless Grinding
Schumag Schumacher Metallwerke, Aachen, Germany.

MACHINERY—Chain Making
Nilson, A. H. Machine Co., Bridgeport, Conn.
Wafios, Maschinenfabrik, Reutlingen, Wurtt., Germany

MACHINERY—Closing Rope
Niehaus, K. A., Maschinenfabrik, Dusseldorf-Rath, Germany
Watson Machine Co., Paterson, N. J.

MACHINERY—Coiling Rod
Vaughn Mach'y Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.

MACHINERY—Cold Heading
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.

MACHINERY—Copper Wire Drawing
American Insulating Mach'y Co., Phila., Pa.
National Mach'y Exch. (Used), New York.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.

MACHINERY—Covering Wire (See MACHINERY—Insulating Wire)

MACHINERY—Cutting
Lewis Machine Co., The, Cleveland, Ohio
Mettler Machine Tool, Inc., New Haven, Conn.
Wells, Frank L., Co., Kenosha, Wis.

MACHINERY—Diameter Testing Continuous
Standard Electronic Research, New York, New York.

MACHINERY—Descaling Rod, Dry
Fisher Associates, New York, N. Y.
Herborn, Herborn, Germany.

MACHINERY—Die Making
Boulin, Victor J., Inc., New York, N. Y.
Carboloy Dept. General Electric Co., Detroit, Mich.
Dykrex Corp., Roos Tool & Mfg. Div., Newark, N. J.
Firth Sterling, Inc., Pittsburgh, Pa.
Wayne Wire Die Co., Hillside, N. J.

WHERE TO BUY, Continued

For more complete information, consult the annual Wire and Wire Products Buyers' Guide.

MACHINERY—Draw Benches
Morgan Construction Co., Worcester, Mass.
Torrington Mfg. Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Edging (See MACHINERY — Tandem Rolling and Edging Mills)

MACHINERY—Enameling
American Insulating Mach'y Co., Phila., Pa.
Cook Manufacturing Co., The, Paterson, N. J.
Industrial Ovens, Inc., Cleveland, Ohio
Michigan Ovens, Inc., Detroit, Michigan
Rockwell Co., W. S., Fairfield, Conn.

MACHINERY—Extruding
Davis-Standard Sales Corp., Mystic, Conn.
Entwistle, James L., Company, Providence, R. I.
Modern Plastic Machinery Co., Lodi, N. J.
Royle, John, & Sons, Paterson, N. J.
Wire & Textile Mach'y, Inc. (used) Pawtucket, R. I.

MACHINERY—Fence
Blashill and Company, Arthur, Worcester, Mass.
Glader, Wm., Machine Works, Chicago, Ill.
Interlocking Fence Co., Morton, Ill.

MACHINERY—Flat Wire
Fenn Manufacturing Co., Newington, Conn.
Mettler Machine Tool, Inc., New Haven, Conn.
Rockwell, W. S., Company, Fairfield, Conn.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Forming Wire
Baird Machine Co., Stratford, Conn.
Nilson, A. H., Machine Co., Bridgeport, Conn.
Wafios, Maschinenfabrik, Reutlingen, Wurtt., Germany

MACHINERY—Galvanizing Wire
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Wilson, Lee, Engr. Co., Cleveland, Ohio

MACHINERY—Gang Winders
Entwistle, Jas. L. Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Grinding
Norton Co., The, Worcester, Mass.

MACHINERY—Insulating Wire
American Insulating Mach'y Co., Phila., Pa.
Davis-Standard Sales Corp., Mystic, Conn.
Fidelity Machine Co., Inc., Philadelphia, Pa.
Michigan Ovens, Inc., Detroit, Michigan
Modern Plastic Machinery Company, Lodi, N. J.
New England Butt Co., Providence, R. I.
Pourtier Pere et Fils, Romainville (Seine), France
Royle, John & Sons, Paterson, N. J.
Syncro Machine Co., Perth Amboy, N. J.
Wardwell Braiding Mach. Co., Central Falls, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Knitting
Fidelity Machine Co., Inc., Philadelphia, Pa.

MACHINERY—Lacquering Electric Wire
American Insulating Mach'y Co., Philadelphia.
Cook Mfg. Co., The, Paterson, N. J.
Industrial Ovens, Inc., Cleveland, O.
Michigan Ovens, Inc., Detroit, Michigan

MACHINERY—Lock Washer
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Looms, Wire Weaving
Interlocking Fence Co., Morton, Ill.
Mummert-Dixon Co., Hanover, Pa.
Wafios, Maschinenfabrik, Reutlingen, Wurtt., Germany

MACHINERY—Material Handling
(See Material Handling Equipment)

MACHINERY—Measuring Wire & Cable
Davis Electric Company, Wallingford, Conn.
Durant Mfg. Co., Milwaukee, Wis.
Entwistle, James L., Company, Providence, R. I.
New England Butt Co., Providence, R. I.
Standard Mill Supply Co., Pawtucket, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Nail and Tack
Baird Machine Co., The Stratford, Conn.
Glader, Wm., Machine Works, Chicago, Ill.
National Mach'y Exch. (Used), New York, N. Y.
Seybold Transworld Exporters, New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Wafios, Maschinenfabrik, Reutlingen, Wurtt., Germany

MACHINERY—Packaging Wire
Coulter & McKenzie Machine Co., Bridgeport, Conn.

MACHINERY—Pickling
Lewis Welding & Engineering Corp., The, Bedford, Ohio
Youngstown Welding & Eng'g Co., Youngstown, Ohio.

MACHINERY—Pin Making
Baird Machine Co., The, Stratford, Conn.

MACHINERY—Pointing
Morgan Construction Co., Worcester, Mass.
National Mach'y Exch. (Used), New York.
Scudder, E. J., Fdry. & Mach. Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Foundry & Machine Co., Waterbury Conn.

MACHINERY—Poultry Wire Fencing
Interlocking Fence Co., Morton, Ill.

MACHINERY—Pumps for Molten Metal
Wire Equipment Mfg. Co., Trenton, N. J.

MACHINERY—Re-Spooling
Boyd & Sons Manufacturing Corp., Philadelphia, Pa.
Davis Electric Company, Wallingford, Conn.
Emory, Robert J., Co., Newark, N. J.
Federal Manufacturing Co., Wallingford, Conn.
Mummert-Dixon Co., Hanover, Pa.
National Mach'y Exch. (Used), New York,
Vaughn Machinery Co., Cuyahoga Falls, O.
Watson Machine Co., Paterson, N. J.
Wire Equipment Mfg. Co., Trenton, N. J.
Wire & Textile Mach'y, Inc. (used) Pawtucket, R. I.

MACHINERY—Rod Mill
Fenn Manufacturing Co., Newington, Conn.
Morgan Construction Co., Worcester, Mass.
Schumag Schumacher Metallwerke, Aachen, Germany

MACHINERY—Rolling Mill
Fenn Manufacturing Co., Newington, Conn.
Morgan Construction Co., Worcester, Mass.
Torrington Mfg. Co., Torrington, Conn.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.

MACHINERY—Rubber Insulating
Davis-Standard Sales Corp., Mystic, Conn.
Modern Plastic Machinery Co., Lodi, N. J.
Royle, John & Sons, Paterson, N. J.
Wire & Textile Mach'y, Inc. (used) Pawtucket, R. I.

MACHINERY—Serving
Fidelity Machine Co., Phila., Pa.
Pourtier Pere et Fils, Romainville (Seine), France
Wardwell Braiding Machine Co., Central Falls, R. I.

MACHINERY—Spark Testing
Davis Electric Company, Wallingford, Conn.
Entwistle, James L., Company, Providence, R. I.
Federal Manufacturing Co., Wallingford, Conn.
Modern Plastic Machinery Co., Lodi, N. J.
Peschel Electronics, Inc., New Rochelle, N. Y.
Wire & Textile Mach'y, Inc. (used) Pawtucket, R. I.

MACHINERY—Spring Making
National Mach'y Exch. (Used), New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., Torrington, Conn.
Wafios, Maschinenfabrik, Reutlingen, Wurtt., Germany
Wells, Frank L., Co., Kenosha, Wisc.

MACHINERY—Staple
Seybold Transworld Exporters, New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Wafios, Maschinenfabrik, Reutlingen, Wurtt., Germany

MACHINERY—Straightening & Cutting
Continental Fdy & Machine Co., Medart Division, Pittsburgh, Pa.
Lewis Machine Co., The, Cleveland, Ohio
Mettler Machine Tool Co., New Haven, Conn.
National Mach'y Exch. (Used), New York, N. Y.
Wells, Frank L., Co., Kenosha, Wisc.

MACHINERY—Stranding
Haskell-Dawes Machine Co., Philadelphia, Pa.
Milton Machine Works, Inc., Milton, Pa.
New England Butt Co., Providence, R. I.
Niehaus, K. A., Maschinenfabrik, Dusseldorf-Rath, Germany
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Swaging
Fenn Manufacturing Co., Newington, Conn.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.

MACHINERY—Take-Up and Pay-Out
American Insulating Mach'y Co., Phila., Pa.
Blashill and Company, Arthur, Worcester, Mass.
Davis Electric Company, Wallingford, Conn.
Davis-Standard Sales Corp., Mystic, Conn.
Entwistle, James L., Company, Providence, R. I.
Federal Manufacturing Co., Wallingford, Ohio
Fenn Manufacturing Co., Newington, Conn.
Industrial Ovens, Inc., Cleveland, Ohio
Modern Plastic Machinery Co., Lodi, N. J.
New York Engineering Co., Yonkers, N. Y.
Standard Mill Supply Co., Pawtucket, R. I.
Watson Machine Co., Paterson, N. J.
Wire Equipment Mfg. Co., Trenton, N. J.

MACHINERY—Taping
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Pourtier Pere et Fils, Romainville (Seine), France
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.
Wire & Textile Mach'y, Inc. (used) Pawtucket, R. I.

MACHINERY—Testing Magnet Wire Coatings for Pin Holes
Federal Manufacturing Co., Wallingford, Ohio
Peschel Electronics, Inc., New Rochelle, N. Y.

MACHINERY—Testing, Physical
Scott Testers, Inc., Providence, R. I.

MACHINERY—Tinning Wire
American Insulating Mach'y Co., Phila., Pa.
Cook Manufacturing Co., The, Paterson, N. J.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Tinsel Rolling Mills
American Insulating Mach'y Co., Phila., Pa.

MACHINERY—Trolley Wire
Torrington Mfg. Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Tube Mill, Cold Drawing
Mettler Machine Tool, Inc., New Haven, Conn.

MACHINERY—Turks Head
Fenn Manufacturing Co., Newington, Conn.

MACHINERY—Twinning
(See Mach.—Bunching)

MACHINERY—Twisters, Wire
Cook Manufacturing Co., The, Paterson, N. J.
Davis Electric Company, Wallingford, Conn.
Edmands Company, The, Providence, R. I.
Haskell-Dawes Machine Co., Philadelphia, Pa.

MACHINERY—Used
National Machinery Exchange, New York, N. Y.
Wire & Textile Machy., Inc., Pawtucket, R. I.

MACHINERY—for Wire Welding
(See WELDERS—Butt and Spot)

WHERE TO BUY, Continued

For more complete information, consult the annual Wire and Wire Products Buyers' Guide.

MACHINERY—Winding Wire
Emory, Robert J., Newark, N. J.
Entwistle, James L., Company, Providence, R. I.
Fenn Manufacturing Co., Newington, Conn.
Mummert-Dixon Co., Hanover, Pa.
New England Butt Co., Providence, R. I.
Standard Mill Supply Co., Pawtucket, R. I.
Watson Machine Co., Paterson, N. J.
Wire Equipment Mfg. Co., Trenton, N. J.

MACHINERY—Wire Drawing
Cook Manufacturing Co., The, Paterson, N. J.
Coulter & McKenzie Machine Co., Bridgeport, Conn.
Fenn Manufacturing Co., Newington, Conn.
Herborn, Herborn, Germany
Morgan Construction Co., Worcester, Mass.
Morgardshammers Mek Verstads AB, Morgardshammer, Sweden
National Mach'y Exch. (Used), New York, N. Y.
Schumag Schumacher Metallwerke, Aachen, Germany
Scudder, E. J., Fdry. & Mach. Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Vaughn Machinery Co., Cuyahoga Falls, Ohio
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.

MACHINERY—Wire Forming
Baird Machine Co., The, Stratford, Conn.
National Mach'y Exch. (Used), New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Wire Rope
Milton Machine Works, Inc., Milton, Pa.
New England Butt Co., Providence, R. I.
Niehaus, K. A., Maschinenfabrik, Dusseldorf-Rath, Germany
Watson Machine Co., Paterson, N. J.

MACHINERY—Wrapping with Paper
Larmuth (1947) Ltd., Swinton, England
Terkelsen Machine Co., Boston, Mass.

MATERIAL HANDLING EQUIPMENT—
Cleveland Tramrail Div. of The Cleveland Crane & Engineering Co., Wickliffe, O.

NAIL TOOLING—Tungsten Carbide
Firth Sterling, Inc., Pittsburgh, Pa.
Pittsburgh Carbide Die Co., Monongahela, Pa.

NAILS—Wire
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Keystone Steel & Wire Co., Peoria, Ill.
Sheffield Steel Corp., Kansas City, Mo.
Wickwire Brothers, Inc., Cortland, N. Y.

NIPPERS—Wire Cutting
Robinson, M. W. Co., Rockfall, Conn.

NOZZLES—For Extruding Machines
Wire Tool Div., Bridgeport Jig Boring Co., Bridgeport, Conn.

OVENS—Cable Lacquering and Enameling
American Insulating Mach'y Co., Phila., Pa.
Carl-Mayer Corp., The, Cleveland, Ohio
Industrial Ovens, Inc., Cleveland, Ohio
Michigan Ovens, Inc., Detroit, Michigan
Rockwell Co., W. S., Fairfield, Conn.

OVENS—Rod Bakers
Carl-Mayer Corp., The, Cleveland, Ohio

OVENS—Welding Rod Coating
Carl-Mayer Corp., The, Cleveland, Ohio
Industrial Ovens, Inc., Cleveland, Ohio

PAINT BONDING CHEMICALS—
American Chemical Paint Co., Ambler, Pa.

PAINTS—Heat Resisting
American Chemical Paint Co., Ambler, Pa.

PANS—Spelter, Galvanizing, Lead
National Annealing Box Co., Washington, Pa.

PAPER—Creped Wrapping
Arkell Safety Bag Company, New York, N. Y.
National Waterproof Papers, Inc., Beverly, N. J.
Terkelsen Machine Co., Boston, Mass.

PAPER—For Coil Wrapping and Corrosion Prevention
Arkell Safety Bag Company, New York, N. Y.
National Waterproof Papers, Inc., Beverly, N. J.
Terkelsen Machine Co., Boston, Mass.

PAPER—Insulating
Plymouth Cordage Co., Plymouth, Mass.

PATENT ATTORNEYS—
Lancaster, Allwine & Rommel, Washington, D. C.

PAY-OUT SYSTEMS—
(See MACHINERY—Take-Up & Pay-Out)

PHOSPHATE COATING CHEMICALS
(See COMPOUNDS—Phosphate Coating)

PICKLING COMPOUNDS—
See (Inhibitors—Pickling)

PICKLING—Hooks, etc. Acid Resisting
Lewis Welding and Engineering Corp., The, Bedford, Ohio
Youngstown Welding & Eng'g Co., Youngstown, Ohio

PICKLING TANK LININGS—
Chemsteel Construction Co., Inc., Pittsburgh, Pa.
Haveg Corp., Newark, Del.

PIPES & FITTINGS—Acid Resistant
Haveg Corp., Newark, Del.

PLASTICIZERS—
Celanese Corporation of America, New York, N. Y.
Monsanto Chemical Co., St. Louis, Mo.
Naugatuck Chemical Div., U. S. Rubber Co., New York, N. Y.

PLASTICS—for Wire Insulation
Carbro Chemical Co., Pawtucket, R. I.
Celanese Corporation of America, New York, N. Y.
Electronic Rubber Co., Stamford, Conn.
Monsanto Chemical Co., St. Louis, Mo.
Naugatuck Chemical Div., U. S. Rubber Co., New York, N. Y.

POTS—Lacquer
Industrial Ovens, Inc., Cleveland, Ohio

POTS—Wire Tinning
National Annealing Box Co., Washington, Pa.

PULLERS AND GRIPS—For Wire
Morgan Construction Co., Worcester, Mass.
Scudder, E. J. Fdry. & Mach. Co., Trenton, N. J.
Sjogren Tool and Machine Co., Auburn, Mass.
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, Ohio

PUMPS—Molten Metal
Fisher Associates, New York, N. Y.

REEL AND TENSION STANDS—
Davis Electric Company, Wallingford, Conn.
Fidelity Machine Company, Inc., Philadelphia
Industrial Ovens, Inc., Cleveland, Ohio.
New York Engineering Co., Yonkers, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Mill Supply Co., Pawtucket, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

REEL CRUTCHES—
Watson Machine Co., Paterson, N. J.

REELS & SPOOLS—Aluminum Alloy
Acrometal Products, Inc., Minneapolis, Minn.
Hubbard Spool Co., Garrett, Ind.
Milton Machine Works, Inc., Milton, Pa.
Wardwell Braiding Machine Co., Central Falls, R. I.

REELS & SPOOLS—Annealing and Stranding
Acrometal Products, Inc., Minneapolis, Minn.
American Pulley Co., Philadelphia, Pa.
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Co., Garrett, Ind.
Milton Machine Works, Inc., Milton, Pa.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Republic Steel Corp., Pressed Steel Div., Niles, Ohio

REELS—Metal Bound
Durkee Mfg. Co., Pine River, Minn.
Hubbard Spool Co., Garrett, Ind.
McCaskie, Inc., Wm., Westport, Mass.
Strand-Buffalo Corporation, North Tonawanda, N. Y.

REELS—Plywood
Hubbard Spool Co., Garrett, Ind.
McCaskie, Inc., Wm., Westport, Mass.
Nelson Company, The, Baltimore, Md.
Strand-Buffalo Corporation, North Tonawanda, N. Y.

REELS & SPOOLS—Steel (All Types)
Acrometal Products, Inc., Minneapolis, Minn.
American Pulley Co., Philadelphia, Pa.
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L. Mfg. Co., Rockford, Ill.
Hubbard Spool Co., Garrett, Ind.
Mason Can Company, East Providence, R. I.
Milton Machine Works, Inc., Milton, Pa.
Mossberg Pressed Steel Corp., Attleboro, Mass.
New York Engineering Co., Yonkers, N. Y.
Republic Steel Corp., Pressed Steel Div., Niles, Ohio
Wardwell Braiding Machine Co., Central Falls, R. I.

REELS—Wire Mill
Acrometal Products, Inc., Minneapolis, Minn.
American Pulley Co., Philadelphia, Pa.
Apco Mossberg Co., Attleboro, Mass.
Bridge Mfg. Co., The, Hazardville, Conn.
Durkee Mfg. Co., Pine River, Minn.
Hubbard Spool Co., Garrett, Ind.
Mason Can Company, East Providence, R. I.
McCaskie, Inc., Wm., Westport, Mass.
Mettler Machine Tool, Inc., New Haven, Conn.
Milton Machine Works, Inc., Milton, Pa.
Mossberg Pressed Steel Corp., Attleboro, Mass.
New York Engineering Co., Yonkers, N. Y.
Republic Steel Corp., Pressed Steel Div., Niles, Ohio
Wardwell Braiding Machine Co., Central Falls, R. I.

REELS & SPOOLS—Wooden
American Woodworking Co., Chicago, Ill.
Bridge Mfg. Co., Inc., The, Hazardville, Conn.
Durkee Mfg. Co., Pine River, Minn.
Hubbard Spool Co., Garrett, Ind.
Nelson Company, The, Baltimore, Md.
Strand-Buffalo Corporation, North Tonawanda, N. Y.

REFRACTORIES—High Temperature
Norton Company, Worcester, Mass.

RETORTS—Annealing
National Annealing Box Co., Washington, Pa.

ROD BAKERS—
(See OVENS—Rod Bakers)

RODS—Stainless Steel
American Steel & Wire Div., United States Steel Corp., Cleveland, O.
Crucible Steel Co. of America, Pittsburgh, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.

RODS—Wire—Non-Ferrous
Chase Brass & Copper Co., Waterbury, Conn.
Kaiser Aluminum & Chemical Corp., Oakland, Calif.
Platt Bros. & Co., The, Waterbury, Conn.
Scovill Mfg. Co., Waterbury, Conn.
Titan Metal Manufacturing Co., Bellefonte, Pa.

RODS—Steel
American Steel & Wire Div., United States Steel Corp., Cleveland, O.
Bethlehem Steel Co., Bethlehem, Pa.
Colorado Fuel and Iron Corporation, Pacific Coast Division, Oakland, Calif.
Continental Steel Corp., Kokomo, Ind.
Crucible Steel Co. of America, Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Sheffield Steel Corp., Kansas City, Mo.
Youngstown Sheet & Tube Co., Youngstown, O.

ROLLS—Wire Straightening
Lignum-Vitae Products Corp., Jersey City, N. J.

ROPE—Wire
Bethlehem Steel Co., Bethlehem, Pa.
Roebling's, John A. Sons Corp., Trenton, N. J.

RUST PROOF COMPOUNDS—
(See COMPOUNDS—Rust Preventing)

RUST REMOVING COMPOUNDS—
(See COMPOUNDS—Rust Preventing)

SATURANTS—Cable
Carbro Chemical Company, Pawtucket, R. I.

SATURATION SYSTEMS—
Industrial Ovens, Inc., Cleveland, Ohio
New York Engineering Co., Yonkers, N. Y.
Watson Machine Co., Paterson, N. J.
Wire & Textile Mach'y, Inc. (used) Pawtucket, R. I.

SHEAVES—Wood
Lignum-Vitae Products Corp., Jersey City, N. J.

SOAPS—Industrial and Wire Drawing
(See COMPOUNDS—Wire Drawing)

SPOOLS—(See Reels & Spools)

SPOOLS—Stamped Metal for Retail Wire Sales
Clark, J. L. Mfg. Co., Rockford, Ill.
Mason Can Co., East Providence, R. I.

STAMPINGS—Steel
Acrometal Products, Inc., Minneapolis, Minn.
Mossberg Pressed Steel Corp., Attleboro, Mass.

STRIP—Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Jones & Laughlin Steel Corporation, Pittsburgh, Pa.
Roebling's, John A. Sons Corp., Trenton, N. J.
Youngstown Sheet & Tube Co., Youngstown, O.

WHERE TO BUY, Continued

For more complete information, consult the annual Wire and Wire Products Buyers' Guide.

TANKS—Compound
National Annealing Box Co., Washington, Pa.
New York Engineering Co., Yonkers, N. Y.
Watson Machine Co., Paterson, N. J.

TANKS—Pickling and Plating
Chemsteel Construction Co., Inc., Pittsburgh, Pa.
National Annealing Box Co., Washington, Pa.

TESTERS — INSULATION
(See MACHINERY—Spark Testers)

TESTING EQUIPMENT
(See MACHINERY Testing, Physical and Diameter Testing)

TINSEL—Electric Conductor
Kassel Export Company, New York, N. Y.
Montgomery Co., The, Windsor Locks, Conn.

TINSEL WIRE—Resistance, Lame, Decorative Cords Thread—Bare Copper, Silver and False Gold Coated, etc.
(See TINSEL—Electric Conductor)

TOOLS—Nail Machine
Pittsburgh Carbide Die Co., Monongahela, Pa.
Wire Equipment Mfg. Co., Trenton, N. J.

TOOLS—Wire Cutting
Porter, H. K. Inc., Somerville, Mass.

TRAMRAIL SYSTEMS—
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, O.

TRANSMISSIONS—Variable speed (See Machy—Power Transmission)

TRAVERSES & DRUMS—For Reels
(See Drums & Traverses)

TRAVERSE MECHANISMS—
Apco Mossberg Co., Attleboro, Mass.
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.
Wire & Textile Mach'y, Inc. (used) Pawtucket, R. I.

VALVES & FITTINGS—Acid Resistant
Haveg Corp., Newark, Del.

VARNISHES & LACQUERS—for Electric Wire
Carbro Chemical Co., Pawtucket, R. I.
Chemical Products Co., E. Providence, R. I.

VULCANIZING PANS AND EQUIPMENT—
American Insulating Mach'y Co., Phila., Pa.
Mossberg Pressed Steel Corp., Attleboro, Mass.

WELDERS—Spot and Butt
Micro Products Co., Chicago, Ill.

WIRE—Aluminum
Elmet Division, North American Philips Company, Inc., Lewiston, Maine
Kaiser Aluminum & Chemical Corp., Oakland, Calif.
Malin & Co., The, Cleveland, Ohio
National Standard Company, Niles, Mich.
Scovill Mfg. Co., Waterbury, Conn.

WIRE—Barbed
Interlocking Fence Co., Morton, Ill.
Jones & Laughlin Steel Corporation, Pittsburgh, Pa.

WIRE—Brass
Chase Brass & Copper Co., Waterbury, Conn.
Scovill Mfg. Co., Waterbury, Conn.
Spencer Wire Corp., Union, N. J.
Titan Metal Manufacturing Co., Bellefonte, Pa.

WIRE—Brush
Spencer Wire Corp., Union, N. J.

WIRE—Bunched & Stranded, Copper
Camden Wire Co., Camden, N. Y.
Utica Wire Corp., Derby, Conn.

WIRE—Cast
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Cold Heading
American Steel & Wire Div., United States Steel Corp., Cleveland, O.
Bethlehem Steel Co., Bethlehem, Pa.
Camden Wire Co., Camden, N. Y.
Chase Brass & Copper Co., Waterbury, Conn.
Colorado Fuel and Iron Corporation, Pacific Coast Division, Oakland, Calif.
Continental Steel Corp., Kokomo, Ind
Crucible Steel Co. of America, Pittsburgh, Pa.
Jones & Laughlin Steel Corporation, Pittsburgh, Pa.
Kaiser Aluminum & Chemical Corp., Oakland, Calif.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Scovill Mfg. Co., Waterbury, Conn.
Sheffield Steel Corp., Kansas City, Mo.
Titan Metal Manufacturing Co., Bellefonte, Pa.
Wickwire Steel Div., The Colorado Fuel & Iron Corp., New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Copper
Camden Wire Co., Inc., Camden, N. Y.
Chase Brass & Copper Co., Waterbury, Conn.
Spencer Wire Corp., Union, N. J.
Utica Wire Corp., Derby, Conn.

WIRE—For Electrical Conductors
Camden Wire Co., Camden, N. Y.
Kaiser Aluminum & Chemical Corp., Oakland, Calif.

WIRE—Flat, Fine
Montgomery Co., The, Windsor Locks, Conn.

WIRE—Galvanized
American Steel & Wire Div., United States Steel Corp., Cleveland, O.
Colorado Fuel and Iron Corporation, Pacific Coast Division, Oakland, Calif.
Jones & Laughlin Steel Corporation, Pittsburgh, Pa.
National Standard Company, Niles, Mich.
Roebling's, John A. Sons Corp., Trenton, N. J.
Sheffield Steel Corp., Kansas City, Mo.
Wickwire Steel Div., Colorado Fuel & Iron Corp., New York, N. Y.

WIRE—Magnet
Kassel Export Company, New York, N. Y.

WIRE—Manufacturers
Alloy Metal Wire Div., H. K. Porter Company, Inc., Prospect Park, Pa.
American Steel & Wire Div., United States Steel Corp., Cleveland, O.
Bethlehem Steel Co., Bethlehem, Pa.
Chase Brass & Copper Co., Waterbury, Conn.
Colorado Fuel and Iron Corporation, Pacific Coast Division, Oakland, Calif.
Continental Steel Corp., Kokomo, Ind.
Crucible Steel Co. of America, Pittsburgh, Pa.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Jones & Laughlin Steel Corporation, Pittsburgh, Pa.
Kaiser Aluminum & Chemical Corp., Oakland, Calif.
Keystone Steel & Wire Co., Peoria, Ill.
National Lock Washer Company, The, Newark, N. J.
North American Philips Co., Inc., Elmet Division, Lewiston, Me.
Pittsburgh Steel Co., Pittsburgh, Pa.
Roebling's, John A., Sons Corp., Trenton, N. J.
Scovill Mfg. Co., Waterbury, Conn.
Sheffield Steel Corp., Kansas City, Mo.
Spencer Wire Corp., Union, N. J.
Titan Metal Manufacturing Co., Bellefonte, Pa.
U. S. Steel Corp., N. Y., N. Y.
Wickwire Brothers, Inc., Cortland, N. Y.
Wickwire Steel Div., Colorado Fuel & Iron Corp., New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Molybdenum
Kassel Export Company, New York, N. Y.

WIRE—Music
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Malin & Co., The, Cleveland, Ohio
Spencer Wire Corp., Union, N. J.

WIRE—Needle
Carpenter Steel Company, Webb Wire Division, New Brunswick, N. J.

WIRE—Nickel Silver and Phosphor Bronze
Alloy Metal Wire Div., H. K. Porter Co., Inc., Pittsburgh, Pa.
Chase Brass & Copper Co., Waterbury, Conn.
Malin & Co., The, Cleveland, Ohio
Titan Metal Manufacturing Co., Bellefonte, Pa.

WIRE—Oil Tempered
Crucible Steel Co. of America, Pittsburgh, Pa.
Jones & Laughlin Steel Corporation, Pittsburgh, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.
Roebling's, John A., Sons Corp., Trenton, N. J.
Sheffield Steel Corp., Kansas City, Mo.

WIRE—Silver Plated Copper
Camden Wire Co., Camden, N. Y.

WIRE—Special Shapes
Alloy Metal Wire Div., H. K. Porter Co., Inc., Pittsburgh, Pa.
Continental Steel Corp., Kokomo, Ind.
Crucible Steel Co. of America, Pittsburgh, Pa.
National Lock Washer Company, The, Newark, N. J.
Titan Metal Manufacturing Co., Bellefonte, Pa.

WIRE—Spring
Alloy Metal Wire Div., H. K. Porter Co., Inc., Pittsburgh, Pa.
American Steel & Wire Div., United States Steel Corp., Cleveland, O.
Bethlehem Steel Co., Bethlehem, Pa.
Colorado Fuel and Iron Corporation, Pacific Coast Division, Oakland, Calif.
Continental Steel Corp., Kokomo, Ind.
Crucible Steel Co. of America, Pittsburgh, Pa.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Jones & Laughlin Steel Corporation, Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
National Standard Company, Niles, Mich.
Pittsburgh Steel Co., Pittsburgh, Pa.
Roebling's, John A., Sons Corp., Trenton, N. J.
Sheffield Steel Corp., Kansas City, Mo.
Wickwire Steel Div., Colorado Fuel & Iron Corp., New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Stainless Steel
American Steel & Wire Div., United States Steel Corp., Cleveland, O.
Carpenter Steel Company, Webb Wire Div., New Brunswick, N. J.
Crucible Steel Co. of America, Pittsburgh, Pa.
Firth Sterling, Inc., Pittsburgh, Pa.
Major Co., J., Chicago, Ill.
National Lock Washer Company, The, Newark, N. J.
National Standard Company, Niles, Mich.
Pittsburgh Steel Co., Pittsburgh, Pa.

WIRE—Steel—Also Coppered and Galvanized Steel
Alloy Metal Wire Div., H. K. Porter Co., Inc., Pittsburgh, Pa.
American Steel & Wire Div., United States Steel Corp., Cleveland, O.
Bethlehem Steel Co., Bethlehem, Pa.
Colorado Fuel and Iron Corporation, Pacific Coast Division, Oakland, Calif.
Continental Steel Corp., Kokomo, Ind.
Crucible Steel Co. of America, Pittsburgh, Pa.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Jones & Laughlin Steel Corporation, Pittsburgh, Pa.
Keystone Steel & Wire Co., Peoria, Ill.
Major Co., J., Chicago, Ill.
National Standard Company, Niles, Mich.
Pittsburgh Steel Co., Pittsburgh, Pa.
Roebling's, John A., Sons Corp., Trenton, N. J.
Sheffield Steel Corp., Kansas City, Mo.
Spencer Wire Corp., Union, N. J.
U. S. Steel Export Co., New York, N. Y.
Wickwire Brothers, Inc., Cortland, N. Y.
Wickwire Steel Div., Colorado Fuel & Iron Corp., New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O

WIRE—Straightening and Cutting
Colorado Fuel and Iron Corporation, Pacific Coast Division, Oakland, Calif.
Jones & Laughlin Steel Corporation, Pittsburgh, Pa.
Major Co., J., Chicago, Ill.
Wickwire Brothers, Inc., Cortland, N. Y.
Wickwire Steel Div., Colorado Fuel & Iron Corp., New York, N. Y.

WIRE—Tinned Copper
Camden Wire Co., Camden, N. Y.
Jury's Wire Products, Inc., Bloomfield, N. J.
Spencer Wire Corporation, Union, New Jersey
Utica Wire Corp., Derby, Conn.

WIRE—Tungsten
Kassel Export Company, New York, N. Y.

WIRE—Zinc
Platt Bros. & Co., The, Waterbury, Conn.

WOOD—for Guide, Rolls, Bushings, Wear Parts, etc.
Lignum-Vitae Products Corp., Jersey City, N. J.

WRAPPING PAPER—Creped
(See PAPER—Creped Wrapping)

YARNS & TAPES—Insulating
Celanese Corporation of America, New York, N. Y.
Pittsburgh Plate Glass Company, Pittsburgh, Pa.
Standard Film Products Corp., Pawtucket, R. I.
Synthetic Thread Corporation, Bethlehem, Pa.

YARN TESTERS—
Scott Testers, Inc., Providence, R. I.

The WATSON MACHINE COMPANY

ESTABLISHED 1845

PATERSON 3, NEW JERSEY, U. S. A.

ELECTRICAL WIRE AND CABLE, WIRE ROPE, CORDAGE AND MASTICATING MACHINERY MANUFACTURERS

WATSON

SELF-POWERED SHAFTLESS TAKEUPS TYPE "V"

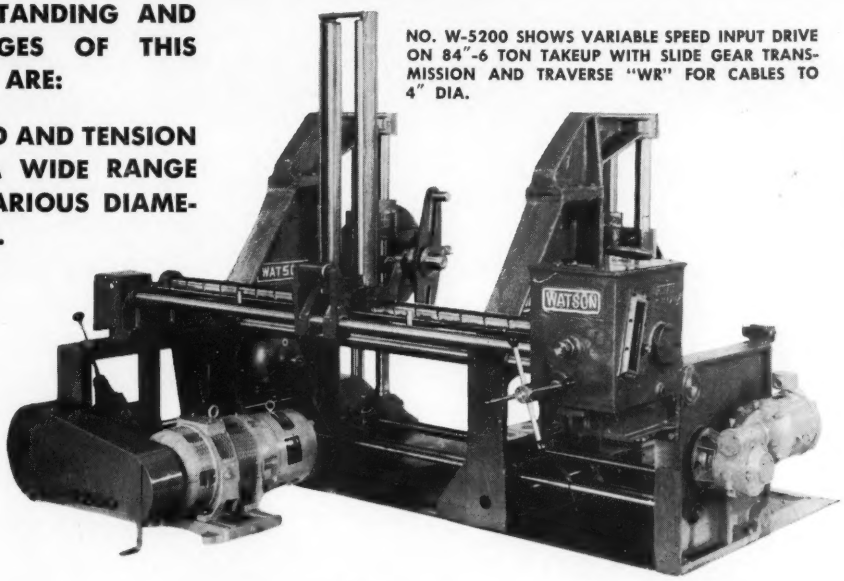
TAKEUPS OF THIS FOREMOST DESIGN, CAPABLE OF THE HEAVIEST DUTY, FURNISHED WITH A VARIABLE SPEED DRIVE MOTOR MAKE THESE UNITS COMPLETELY INDEPENDENT OF IN-LINE EQUIPMENT AND ESPECIALLY SUITED FOR USE WITH LARGE EXTRUDING, LEAD SHEATHING AND TAPING MACHINES.

SOME OF THE OUTSTANDING AND NOTABLE ADVANTAGES OF THIS "SHAFTLESS" DESIGN ARE:

1—VERSATILITY—SPEED AND TENSION CONTROL OVER A WIDE RANGE WITH REELS OF VARIOUS DIAMETERS AND WIDTHS.

2—SAFETY — ELIMINATION OF ACCIDENTAL INJURY DUE TO HANDLING OF LARGE REEL SHAFTS.

NO. W-5200 SHOWS VARIABLE SPEED INPUT DRIVE ON 84"-6 TON TAKEUP WITH SLIDE GEAR TRANSMISSION AND TRAVERSE "WR" FOR CABLES TO 4" DIA.

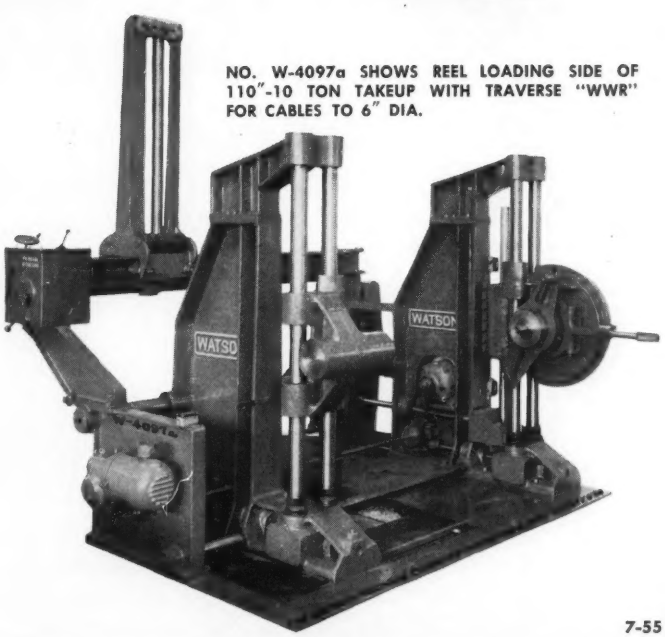


3—FULL MOTORIZATION—DRIVE, REEL LIFT AND FRAME SHIFT ARE ALL MOTOR DRIVEN.

4—EASE — ALL CONTROLS AND ADJUSTMENTS EFFECTED WITH A MINIMUM OF EFFORT.

5—RAPIDITY — LARGEST REELS EASILY AND RAPIDLY ENTERED AND DISCHARGED.

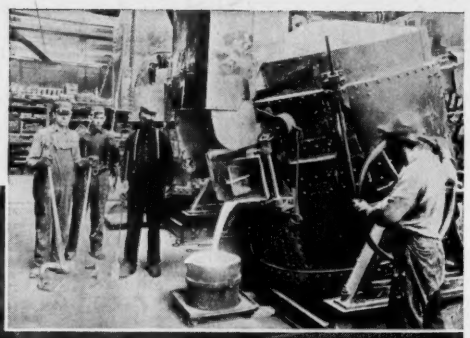
NO. W-4097a SHOWS REEL LOADING SIDE OF 110"-10 TON TAKEUP WITH TRAVERSE "WWR" FOR CABLES TO 6" DIA.

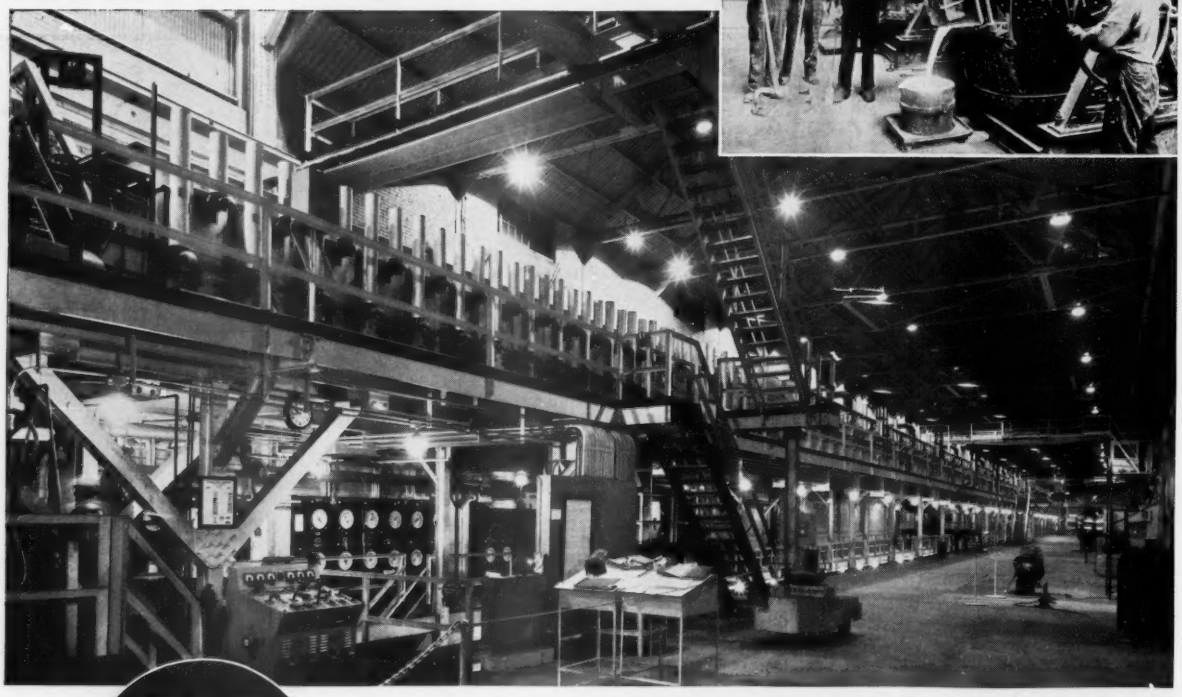


AVAILABLE IN 5 SIZES FOR REELS TO 120" DIA.

7-55

The first Electric Brass Melting Furnace in America — built by The Electric Furnace Co., Salem, Ohio.





An EF combination electric and gas fired furnace installation in a prominent steel plant producing galvanized strip. This equipment flame cleans, uniformly anneals and galvanizes strip continuously.

EF

Continuing to pioneer

New Developments

In the continuous and batch processing of ferrous and non-ferrous products

From the company's beginning, when the little furnace shown above was "big news"; to the modern, completely automatic, high production strip lines, EF research and development engineers have been making important contributions to furnace design and metal processing techniques.

EF engineers conceived and developed the first automatic and continuous heat treating, quenching and drawing equipment; pioneered the use of endothermic, exothermic and other special atmosphere treatments resulting in closer physical tolerances.

Other developments include EF radiant tubes with heat exchangers that assure extremely high combustion efficiency; EF cast alloy electric heating elements; EF roller design—and other facilities that assure uniform temperatures throughout the furnaces, accurate control of heat input, reduced maintenance and high hourly output.

For maximum product uniformity, dependability and efficiency, discuss your heating problems with EF experienced engineers . . . it pays.

EF

THE ELECTRIC FURNACE CO.

GAS FIRED, OIL FIRED AND ELECTRIC FURNACES FOR ANY PROCESS, PRODUCT OR PRODUCTION

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